APPENDIX 3-XII

AIR EMISSIONS EFFECTS
SUPPLEMENTAL INFORMATION

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1 INTRODUCTION

This appendix provides the methods used in the assessment of the potential effects of air emissions on ecological receptors. Section 2 of this appendix provides a review of the potential effects of air emissions on ecological receptors. Section 3 of this appendix is a review of past and present monitoring studies in the Oil Sands Region. Section 4 of this appendix provides a complete description of the assessment methods used for aquatic resources and terrestrial resources, including soils, terrestrial vegetation and wetlands, and wildlife and wildlife habitat. Section 5 of this appendix provides supporting information for the assessment of the effects of acid deposition on aquatic systems and biota.

2 REVIEW OF THE POTENTIAL EFFECTS OF AIR EMISSIONS ON ECOLOGICAL RECEPTORS

2.1 AQUATIC BIOTA

2.1.1 Introduction

Industrial activities have the potential to affect aquatic ecosystems through the release of air emissions that may result in acid deposition. Emissions of oxides of nitrogen (NO_X) and sulphur (SO_2) are the main contributors to acid deposition. Acid deposition causes a reduction of pH in acid-sensitive lakes and streams that in turn may alter other aspects of water chemistry (e.g., the solubility of aluminums). Acidification of surface waters due to air emissions and the resulting biological effects have been widely documented in both North America and Europe (Jeffries 1997; Henriksen et al. 1992).

The effects of acidification on aquatic biota can be divided into two broad classes of effects: direct effects and indirect effects. The direct effects of acidification result largely from the toxic effects of the hydrogen ion (H^+) and increased dissolved aluminium concentrations associated with a drop in pH. Indirect effects of acidification on aquatic organisms may occur through interactions with other organisms that are directly affected (e.g., reduction in the abundance of prey species or an altered balance of competition between species).

2.1.2 Phytoplankton and Zooplankton

Studies on the effects of acidification indicate that increases in acidity are accompanied by reductions in species richness (Havens 1992; Locke 1992; Almer et al. 1974; Roff and Kwiatkowski 1977; Keller and Pitblado 1984; Yan and Dillion 1984; Carter et al. 1986; MacIsaac et al. 1986). The loss of acid-sensitive phytoplankton species results in communities dominated by large-celled algae (e.g., the filamentous alga *Mougeotia*) and in some cases by small (non-filamentous) blue-green algae (Grahn et al. 1974; Lazarek 1983; Schindler et al. 1985; Havens and DeCosta 1987; Turner et al. 1987; Havens and Heath 1990; Webster et al. 1992; Klug and Fischer 2000). The patterns of species loss and replacement in acidic lakes result in zooplankton communities that lack large-bodied planktonic herbivores (e.g., daphnids) and are thus dominated by relatively small species (Jeffries 1997). The largest changes in the species richness and composition of phytoplankton communities usually occur as the pH drops below 5.6, but pronounced changes in community structure have been observed during the early phases of acidification as well (e.g., during a drop in pH from more than 8 to 6) (Yan 1979). For this reason, algae can serve as early indicators of acidification.

Reduced biomass is often associated with increased acidity, but has not been consistently observed in studies of acidified lakes (NRCC 1981; Yan and Struss 1980; Confer et al. 1983; Schindler 1990; Yan and Welbourn 1990; Jeffries 1997).

2.1.3 Macrophytes

The two major effects of acidification on macrophytes include reduced species richness (Roelofs 1983; Kenttamies et al. 1985; Catling et al. 1986; Jackson and Charles 1988; Vestergaard and Sand-Jensen 2000) and changes in species composition (Grahn 1977, 1985, 1986; Halvorsen 1977; Hultberg and Grahn 1975; Morling et al. 1985; Roelofs 1983; Van Dam 1988; Arts et al. 1989). The potential physical and chemical changes in an acidified lake that could indirectly affect growth and distribution of macrophytes include altered transparency and temperature of the water column as well as reduction in the decomposition of cellulose and lignin. Although increased solubility of metals could potentially affect macrophyte growth, many submergent macrophytes can accumulate metals in acidified lakes with no apparent toxicity (Lehtonen 1989).

2.1.4 Benthic Invertebrates

The most important effects of acidification on benthic invertebrate communities are changes in species richness and diversity (Haines 1981; Minns et al. 1990; Schindler 1990, 1997) resulting from elimination of acid-sensitive species, and the invasion and subsequent proliferation of acid-tolerant species (Hall and Ide 1987). Consequently, overall biomass may be affected only slightly or not at all (Ericksson et al. 1980; Dixit and Smol 1989). Acidification typically results in a progressive reduction of species richness.

Despite high variability, certain broad taxonomic groups have been observed to dominate the fauna of lakes with reduced pH, including flies (Diptera), caddisflies (Trichoptera), beetles (Coleoptera), and dragonflies and damselflies (Odonata) (Schell and Kerekes 1989). Mayflies (Ephemeroptera) are generally very sensitive to shifts in pH (Jeffries 1997). Molluscs are sensitive to acidification because of their high calcium carbonate ($CaCO_3$) requirements for shell formation (Haines 1981; Schell and Kerekes 1989). Acidification produces dominance by acid-tolerant species, increases in the abundances of large predatory insects and a shift from grazer to shredder insect dominance (McNicol and Wayland 1992; Appleberg et al. 1993; Bendell and McNicol 1995). Losses of taxa that are important as fish food can be expected to have indirect effects on fish. Indirect effects of acidification on benthic invertebrates include food limitation and shifts in predation. The general result is that the benthic community becomes simpler (i.e., biodiversity is reduced due to the loss of acid-sensitive species) (Jefferies 1997).

2.1.5 Fish

Both low pH and the associated increased aluminum concentrations are directly toxic to fish (Exley et al. 1996). Reduced pH and elevated aluminum can also cause chronic stress that can result in lower body weight and smaller size, which in turn may reduce the capability to compete for food and habitat (European Inland Fisheries Advisory Commission (EIFAC) 1996).

The mechanisms of fish population response to acidification include direct toxicity and indirect effects through alteration of the food web. Direct effects consist of reduced adult survival and recruitment failure (i.e., no young survive to become part of the adult population) (Ingersoll et al. 1990a,b; Wood et al. 1990 a,b). Reduced adult survival may result from fish kills associated with episodic events (these are relatively rare) and high mortality of sensitive adult stages (e.g., after spawning). Migration of adults from acidic systems, a behavioural avoidance reaction, may also reduce adult fish abundance. The causes of recruitment failure include increased mortality of early life stages, impaired reproductive physiology and ovarian maturation, and inhibition of spawning behaviour (United States Environmental Protection Agency (U.S. EPA) 1986).

The direct effects of acidification typically result in a reduction of fish abundance and species richness in acidified streams and lakes (Lacorix and Townsend 1987; Tremblay and Richard 1993). Complete elimination of fish populations has been observed in lakes with a pH of less than 5. Spatial and temporal variability of acidic conditions are important to the magnitude of effects on aquatic biota. For example, even episodic pulses of acidification can lead to significant fish mortality (Wigington et al. 1993).

Because many invertebrate taxa are also sensitive to acidification, detrimental effects on food webs may occur well before direct toxicity to fish becomes evident (Schindler et al. 1989; Gill 1993). Fish populations can undergo significant changes due to altered zooplankton, phytoplankton or benthic invertebrate species composition, which can cause a reduction in the abundances of preferred prey species for fish. Changes in macrophyte abundance can also lead to a change in the population structure and abundance of certain fish species (Gunn and Keller 1990).

2.1.6 Amphibians

The aquatic life stages of amphibians may be adversely affected in acidified lakes and ponds. The most acid-sensitive phase of frog development is the aquatic embryo stage. Each life-stage after the embryo stage, including the semi-terrestrial stage, is increasingly more tolerant of acidic conditions (Pierce et al. 1984).

The direct effects of acidification on amphibians begin to manifest below pH 6 (Doka et al. 1997). Surface waters with pH above 6 are considered optimal for amphibian diversity, hatching success, and tadpole survival and development. Exposure to pH levels below 6 may result in reduced hatching success (Dale et al. 1985; Gascon and Planas 1986), larval mortality (Tome and Pough 1982; Pierce 1985; Leftwich and Lilly 1992), decreased growth and development rates (Freda and Dunson 1985, 1986; Gascon and Planas 1986) and behavioural changes (Freda and Taylor 1992).

2.1.7 Ecosystem Effects

Sensitivity to acidification varies from species to species within each group of organisms and according to several factors, including existing water quality, the exposed life stage and the manner in which species interactions (e.g., competition) are altered within a particular ecosystem (Sullivan 2000).

As lakes and streams become more acidic, the abundance and species richness of aquatic plants and animals generally declines, although abundance of a few acid-tolerant organisms may increase (Table 1). The general result is that the aquatic food web becomes simpler, (i.e., biodiversity is reduced due to the loss of acid-sensitive species). In general, the diversity of aquatic ecosystems begins to decline at a pH of 6 (Research and Monitoring Committee of Canada (RMCC) 1990), although loss of highly acid-sensitive species may occur as pH drops below 6.5.

While increased acidity is seldom directly lethal for large-bodied aquatic organisms, there are important indirect effects such as altered food webs, reduced biodiversity and changes in productivity. Table 1 provides a general summary of the effects of acidification on aquatic ecosystems.

Table 1 Summary of the Biological Effects of Surface Water Acidification

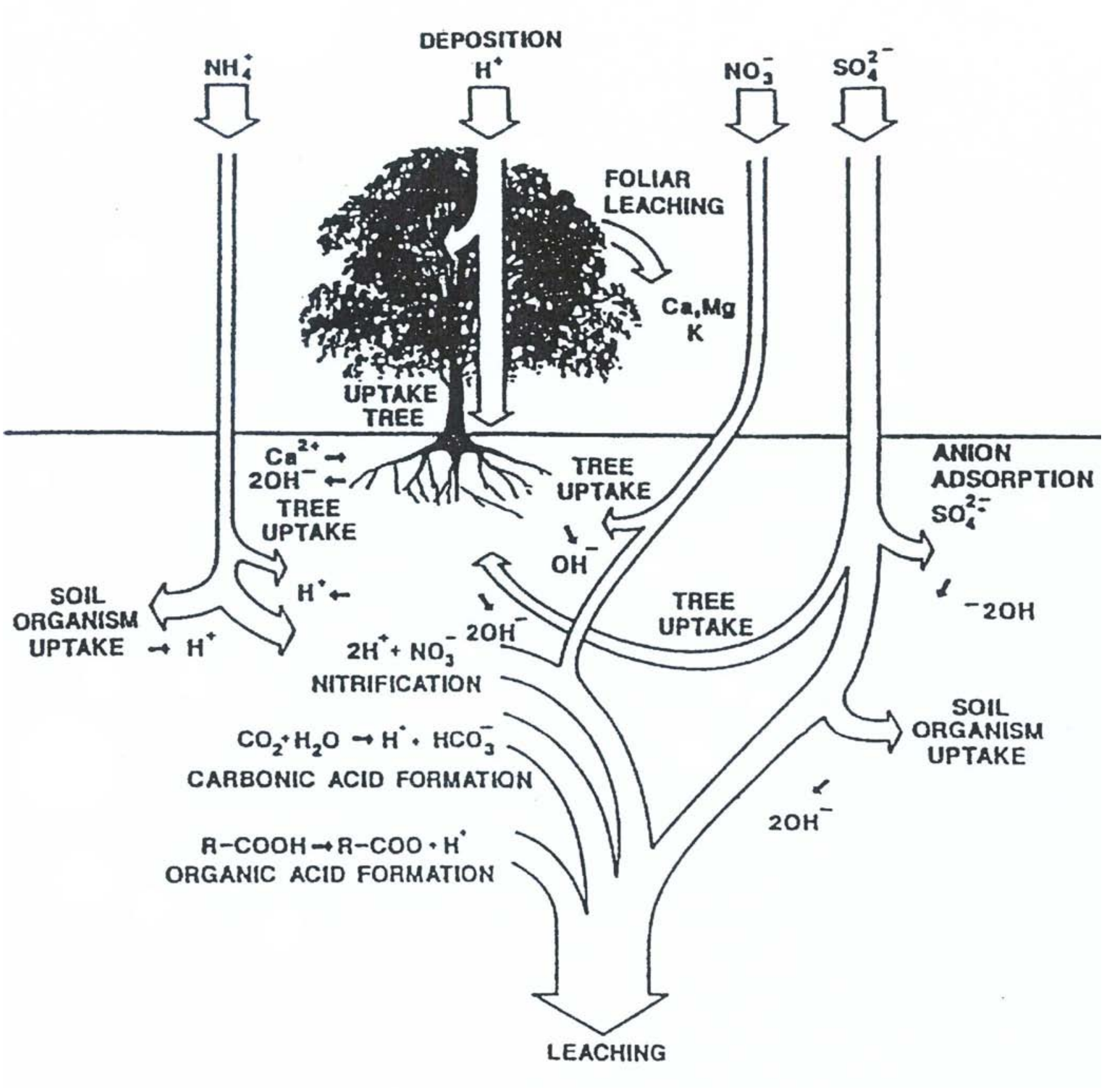
pH Decrease	General Biological Effects
6.5 to 6.0	• small decrease in species richness of phytoplankton, zooplankton and benthic invertebrate communities resulting from the loss of a few highly acid-sensitive species, but no measurable change in total community abundance or production • some adverse effects (decreased reproductive success) may occur for highly acid-sensitive fish species
6.0 to 5.5	• loss of sensitive species of minnows and dace (non-sport fish species); in some waters decreased reproductive success of important sport fish species • visual accumulations of filamentous green algae in the littoral zone of many lakes and in some streams • distinct decrease in species richness and change in species composition of phytoplankton, zooplankton and benthic invertebrate communities, although little if any change in total community biomass or production • loss of several common invertebrate species from zooplankton and benthic communities (many species of snails, clams, mayflies and amphipods, and some crayfish) • reduced hatching success of amphibians
5.5 to 5.0	• loss of several important sport fish species, as well as additional non-sport fish species • further increase in the extent and abundance of filamentous green algae in lake littoral areas and streams • continued shift in the species composition and decline in species richness of phytoplankton, zooplankton and benthic invertebrate communities; decrease in the total abundance and biomass of benthic invertebrate and zooplankton may occur in some waters • loss of several additional invertebrate species common in oligotrophic waters, all snails, most species of clams, and many species of mayflies, stoneflies and other benthic invertebrates • reduced hatching success of amphibians • inhibition of nitrification
5.0 to 4.5	• loss of most fish species, including most important sport fish species; few fish species able to survive and reproduce below pH 4.5 • measurable decline in whole-system rates of decomposition of some forms of organic matter, potentially resulting in decreased rates of nutrient cycling • substantial decrease in the number of species of zooplankton and benthic invertebrates and further decline in the species richness of the phytoplankton and periphyton communities; measurable decrease in the total community biomass of zooplankton and benthic invertebrates in most waters • further loss of zooplankton species and benthic invertebrate species (all clams and many insects and crustaceans) • reproductive failure and larval mortality of acid-sensitive species of amphibians

Source: modified from Baker et al. (1990).

2.2 SOILS

2.2.1 Acidification Background

Soil acidification refers to a set of complex processes that result in the reduction of soil pH and loss of base cations. The mechanisms that cause soil acidification include both natural and anthropogenic (man-made) processes (Figure 1). Natural acidifying processes in forest ecosystems include base cation uptake by plants and microbes, humus formation and natural leaching of base cations by organic and mineral acids (Ulrich 1980) (Figure 1).



REFERENCE

Taylor et al. (1994)

PROJECT

CHRISTINA LAKE REGIONAL PROJECT - PHASE 3

TITLE

SOURCES AND SINKS OF ACIDITY IN A FOREST ECOSYSTEM

MEG ENERGY CORP.

PROJECT	07.1346.0009.8200		FILE No.	Sinks of Acidity
DESIGN	AA	18/12/07	SCALE	N.A. REV. 0
CADD	TRE	10/01/08		
CHECK	TR	28/03/08	**FIGURE: 1**	
REVIEW	IGG	11/04/08		

L:\2007\1346 Oil Sands\07-1346-0009-MEG EXPANSION\8200\8220\Fig 1 Sinks of Acidity.dwg Apr 12, 2008 - 2:48pm

Acidification from anthropogenic processes may result from forest harvesting, fertilization and atmospheric deposition of SO_4^{2-} and NO_3^- (Robarge and Johnson 1992). Soil acidification is recognized as a slow process that may require decades for measurable changes to occur in soils under typical depositional cycles (Bloom and Grigal 1985).

Sulphur (S) and nitrogen (N) emissions may lead to soil acidification. This occurs when these compounds are oxidized to sulphuric acid (H_2SO_4) and nitric acid (HNO_3) and are not balanced by the reduction and/or assimilation of SO_4^{2-} and NO_3^- into the vegetation (De Vries and Breeuwsma 1987; Robarge and Johnson 1992). Scientific opinion is still divided about the contribution of anthropogenic emissions to increasing the acidity of naturally acidic soils such as those in the Oil Sands Region (Turchenek and Lindsay 1982) in comparison to natural causes and land use (Krug and Frink 1983; Tabattabai 1985).

In addition, the buffering properties of naturally acidic soils are somewhat resistant to further changes in pH.

The production of acidity from atmospheric sulphur and nitrogen deposition is illustrated in the following equations:

$$SO_2 + ½O_2 + H_2O = H_2SO_4;\ H_2SO_4 = 2H^+ + SO_4^{2-}\ (1)$$

$$3NO_2 + H_2O = 2HNO_3 + NO;\ 2HNO_3 = NO_3^- + 2H^+\ (2)$$

The potential effects of soil acidification include (Reuss and Johnson 1986; Hall et al. 1997):

- a reduction in soil base saturation;
- an increase in the availability of aluminum in the soil solution to levels, which affect to plant growth; and
- changes in soil fertility and nutrient cycling.

2.2.2 Reduction in Base Saturation

Acid deposition may reduce soil base saturation through the leaching of base cations. As additional NO_3^- and SO_4^{2-} anions are introduced into the soil system from atmospheric deposition, base cations like Ca^{2+} and Mg^{2+} are released from the soil exchange complex to maintain electrical neutrality in the soil solution. The base cations are then replaced with H^+ ions that increase the potential for cation leaching out of the root zone. The formation of ion pairs between Ca and

Mg base cations with NO_3^- and SO_4^{2-} anions may also cause further leaching and loss of Ca^{2+} and Mg^{2+} from the soil. Researchers at the Hubbard Brook Experimental Forest in New Hampshire have documented substantial losses of base cations due to acidifying emissions in Podzolic soils (Likens et al.1996).

Studies indicate that cation depletion could be a significant concern for the long-term maintenance of soil fertility and forest health and productivity at many sites (Huntington 2005). The loss of base cations through leaching reduces nutrients available to plants in the rooting zone. Researchers have found that reductions of soil base saturation below critical levels can reduce forest growth for species such as sugar maple in Quebec (Ouimet et al. 1996) and red oak (Sharpe et al. 1993).

Specifically, researcher's attention has been on the decreased Ca concentrations in the soil pool (Tomlinson 2003; Watmough and Dillon 2003; Hultberg and Ferm 2004; Huntington 2005; Lawrence et al. 2005). Calcium depletion is of concern as it plays a critical role in tree physiology. It is likely that Ca limitation can adversely influence many aspects of forest function.

Tomlinson (2003) found that the first effect of deposition was to increase the Ca^{2+} concentration of the soil solution. This was also seen in the mid-1900s, when an increase in acidic deposition mobilized exchangeable soil Ca^{2+} (Huntington 2005). An increased growth rate in trees ensued, which resulted in the subsequent depletion of exchangeable soil Ca^{2+} as a consequence of the unsustainable rate of growth. Hultberg and Ferm (2004) found that 70% of the total soil pool of exchangeable Ca^{2+} had been lost during the last 100 years of sulphur deposition in forests when tree harvesting occurred. In forest stands where no harvesting occurred, 23% of the soil pool of Ca^{2+} had been lost due to acid deposition. In contrast, natural forests without acid deposition and harvesting would have increased the soil pool of Ca^{2+} by 6%.

One of the largest uncertainties regarding the long-term impact of acidic deposition on the availability of Ca is the rate of weathering replenishment (Huntington 2005). It has become evident that Ca^{2+} and other cationic nutrients entering the soil from dust and rain, weathering, and mineralization will be leached out of the system. Leaching removes several times more Ca^{2+} than is replaced through atmospheric deposition. Watmough and Dillon (2003) found that the exchangeable Ca^{2+} pool in eastern North America is currently large enough to sustain healthy tree growth, but continued losses of Ca^{2+} due to leaching and harvesting may deplete plant-available Ca reserves in the upper soil horizons to the point that forest productivity may be affected within just a few decades.

The availability of soil Ca (and Mg) may be an important control of current and future tree growth in upper northern latitudes because acid deposition has fallen on large areas of the northern temperate and southern boreal forest (Lawrence et al. 2005). With the soil being continuously depleted of Ca^{2+}, a continued decrease in net biomass as well as a decrease in the capability of the forest to regenerate after harvest will occur, unless and until acidifying emissions are greatly reduced (Tomlinson 2003).

2.2.3 Increased Availability of Aluminum

Acid deposition may lead to increased availability of phytotoxic metals such as aluminum by reducing the pH of the soil solution (De Vries 1988; Johnson et al. 1991; Cronan and Grigal 1995). This is released at increasing rates when soil pH drops below 4.5 (Økland et al. 2004). Increased aluminum (Al) in the soil solution may reduce the uptake of base cations by plant roots (Robarge and Johnson 1992; Cronan and Grigal 1995) and inhibit root growth (Nosko et al. 1988; Robarge and Johnson 1992). Mobilization of Al by acid deposition would be expected to increase dissolved Al concentrations in the upper soil profile, where weathering is most intense and organic matter is available, thereby increasing concentrations of exchangeable and organically complexed Al at the expense of colloidal Al (Lawrence et al. 2005). Critical soil solution aluminum values for selected tree species are summarized in Table 2.

Table 2 Critical Soil Solution Aluminum Values That Cause Adverse Effects on Selected Tree Species

Tree Species	Critical Al Concentration (parts per million)	Reference
balsam fir	100	Schier 1985
pine, alder, birch	120	McCormick and Steiner 1978
white spruce	50	Nosko et al. 1988

Lawrence et al. (2005) found that the onset of growth declines during a period of Al mobilization suggests that the trees respond to a decline in soil fertility (Lawrence et al. 2005). Differences among species in ability to recover from damage caused by toxic Al may explain why some vascular plants decrease in abundance while others remain unchanged (Økland et al. 2004).

Research suggests that the toxic effect of aluminum is buffered by the presence of calcium and other base cations and that the Ca/Al ratio or Base Cation (BC)/Al ratio is a valid indicator of forest stress (Sverdrup et al. 1992a; Cronan and

Grigal 1995). Cronan and Grigal (1995) reviewed the literature on Ca/Al relationships using a risk-based approach and concluded the following:

- The Ca/Al ratio can be used as a valuable measurement endpoint for forest damage from Al stress and nutrient imbalances.
- The Ca/Al ratio can be used as an indicator to assess forest system changes over time in response to acid deposition and forest harvesting.
- Use of the Ca/Al index at a single point in time can only provide an index of the potential for Al stress and does not indicate the cause of stress. Therefore, the Ca/Al index is best used to monitor forest stress over time.

Based on their literature review, Cronan and Grigal (1995) recommend the following multiple assessment tools for determining whether an ecosystem has a high probability of suffering Al stress:

- a soil base saturation less than 15% (Reuss 1983; Cronan and Schofield 1990) or 20% in areas of high acid deposition (Cronan and Grigal 1995); and
- a soil solution Ca/Al ratio of 1.0 (50% risk), 0.5 (75% risk), or 0.2 (95 to 100% risk).

A Ca/Al or BC/Al ratio of 1.0 is used in Europe for defining critical loads in forest soils using the simple mass balance method (Sverdrup et al. 1992b). A BC/Al ratio of 1.0 in forest soils measured under laboratory conditions correlates with a root or biomass growth of about 85 to 90% of control values for white spruce, black spruce and sitka spruce. Since the data used to develop the critical BC/Al ratio of 1.0 is derived primarily from laboratory studies, correlation with available field data is uncertain (Sverdrup et al. 1992b).

Therefore, the assertion as to whether the indirect effects of soil acidification on forest growth even occur is still disputed (Sverdrup et al. 1992b). Due to these uncertainties, the BC/Al index should be used cautiously.

2.2.4 Soil Fertility and Nutrient Cycling

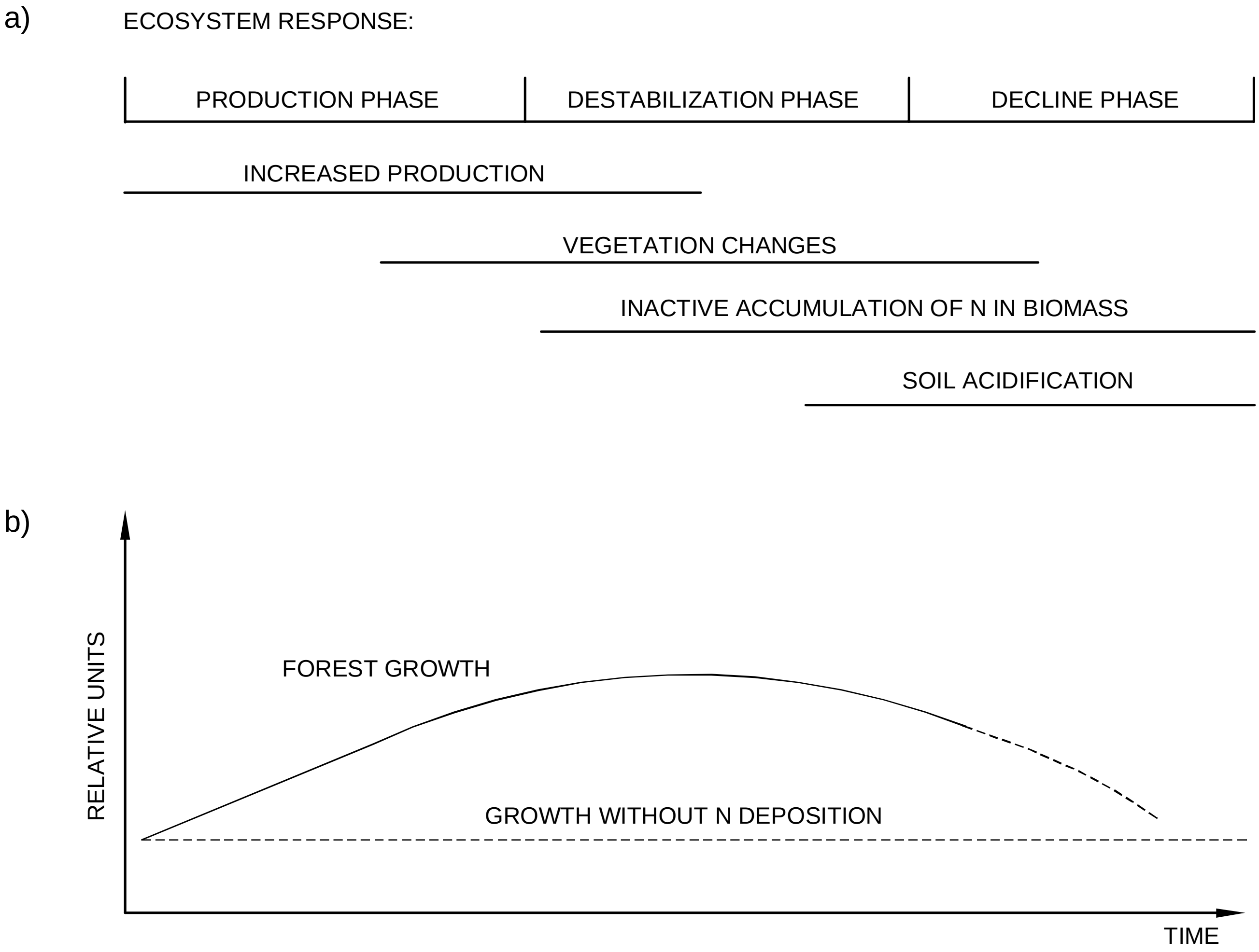
Soil fertility and nutrient cycling may also be affected by acid deposition. Acid deposition is a combination of both nitrogen and sulphur compounds. Increased plant-available nitrogen and sulphur can stimulate growth in boreal forest (Hall et al. 1997) and peatland plant species (Boeye et al. 1997; Thormann and Bayley 1997), as these ecosystems are generally nutrient deficient. However, fertilizer experiments in boreal and peatland ecosystems commonly show growth responses to added nitrogen only (Rochefort and Vitt 1988; Aber et al. 1989).

Excess nitrogen deposition may cause the following changes in boreal forest ecosystems (Aber et al. 1989):

- increased leaching of soil cations that would reduce soil fertility and increase soil acidity;
- potential increases in the greenhouse gas nitrous oxide (N_2O) from increased nitrification, which affects atmospheric chemistry;
- reduced growth of fine roots in trees, thereby potentially reducing nutrient uptake;
- increased boreal forest growth (Sverdrup et al. 1992a; Hall et al. 1997); and
- reduced microbiological diversity and microbial respiration, both of which decrease the rate of organic matter decomposition (Tamm et al. 1980; Hall et al. 1997).

Significant effects of acid deposition on soil biota are only expected to occur when the nitrogen loading is more than 10 keq/ha/yr (Robarge and Johnson 1992). Since boreal forest and peatland ecosystems are nitrogen deficient (Maynard 1996), soil acidification will only occur when NO_3^- deposition exceeds plant requirements (Figure 2).

Ombrotrophic bogs are also naturally nitrogen-deficient ecosystems (Boey et al. 1997; Thormann and Bayley 1997). Little information exists on the potential impacts of nitrogen compounds on peatlands. However, a study conducted on an experimentally acidified nutrient-poor fen in northwestern Ontario (Bayley et al. 1987) reported that the fen was capable of acting as a sink for the added NO_3^- and SO_4^{2-}, due to reduction processes that increased alkalinity.



NOTE

a) Ecosystem stability and effects
b) Changes in growth
The time scale (X-axis) for these changes may differ widely between ecosystems and regions.

REFERENCE

Taylor et al. (1994)

PROJECT

CHRISTINA LAKE REGIONAL PROJECT - PHASE 3

TITLE

POTENTIAL RESPONSE OF BOREAL FOREST ECOSYSTEMS TO NITROGEN DEPOSITION

MEG ENERGY CORP.

PROJECT	07.1346.0009.8200		FILE No.	Boreal Forest
DESIGN	AA	18/12/07	SCALE N.A.	REV. 0
CADD	FN	15/01/08		
CHECK	TR	28/03/08	**FIGURE: 2**	
REVIEW	IGG	11/04/08		

L:\2007\1346 Oil Sands\07-1346-0009-MEG EXPANSION\8200\8220\Fig 2 Boreal Forest.dwg Apr 12, 2008 - 2:50pm

Li and Vitt (1997) applied nitrogen in a rich fen and a bog in western Canada and concluded the following:

- almost all the added nitrogen was immediately sequestered in the moss layer;
- the sequestered nitrogen stimulated new growth of the moss; and
- shrub species did not respond to the added nitrogen initially, but later had growth responses to the nitrogen released through organic matter decomposition.

Stimulation in the growth of mosses from the addition of nitrogen has also been observed by other investigators (Bayley et al. 1987; Rochefort and Vitt 1988), although it can be species specific (Thormann and Bayley 1997). The uptake of nitrate by peatland vegetation can lead to greater alkalinity in the pore water, at least in the short-term, due to the additional alkalinity generated from the release of anions by ion exchange (Bayley et al. 1987). However, the degree of NO_3^- loading from atmospheric sources that may be required to saturate bogs has not been determined (Bayley et al. 1987).

Other studies in northeastern Alberta (Turchenek and Abboud 1995) showed that acid addition to soil had minimal effects.

Bayley et al. (1987) found elevated surface water nitrogen concentrations following six years of applying 50 kg NO_3^-/ha, while Li and Vitt (1997) found no leaching after adding 130 kg NO_3^-/ha.

Due to the short-term nature of artificial acidification studies, it is difficult to extrapolate their results when evaluating long-term effects. Long-term annual atmospheric deposition of nitrate in England (0.6 to 0.7 keq/ha/yr) has been reported to reduce plant growth and decrease the growth of peatlands (Woodin et al. 1985).

2.2.5 Critical Loads

The potential effects of acidifying emissions on sensitive ecosystems have been described in terms of critical loads, which are defined as “the highest load that will not cause chemical changes leading to long-term effects on the most sensitive ecosystem according to our present knowledge” (Bull 1991). An occurrence above the critical load indicates an excess of acidity compared to alkalinity in the soil. This increases the potential for soil acidification, which may ultimately affect forest growth over the long-term (DeVries et al. 1994).

Short-term occurrences above the critical loads will not necessarily result in measurable effects on forest ecosystems, but the risk of impacts increases with time (Maynard 1996).

The SO_2 Management Committee of Alberta's Clean Air Strategic Alliance (CASA) recommended that Alberta adopt the European Potential Acid Input (PAI) approach for determining and managing critical loads (CASA 1996). The European approach is applied on scales of 1° latitude by 1° longitude (60 by 100 km). Table 3 summarizes the generic critical loads that have been adopted by the CASA for soil and water (CASA 1996).

Table 3 Generic Critical Loads Adopted by the Target Loading Subgroup

Soil Sensitivity Rating	Generic Critical Loads [keq/ha/yr][a]
high	>0.25
moderate	>0.50
low	>1.0

[a] Kiloequivalents of hydrogen ion per hectare per year.

Source: Target Loading Subgroup (1996).

Other assessments of critical loads have been made in the Oil Sands Region. Critical loads for sensitive soils estimated by Alberta Environment (AENV) (1990) and the Interim Acid Deposition Critical Loadings Task Group (1990) ranged from 0.1 to 0.31 keq/ha/yr.

Site-specific critical loads have also been calculated on the jack pine (Syncrude 1998; Doram and Arp 1999) and aspen (Doram and Arp 2000) Terrestrial Environmental Effects Monitoring (TEEM) plots using the ForSust steady-state mass balance model. The mean critical load calculated was 0.44 keq/ha/yr for the jack pine plots (Syncrude 1998; Doram and Arp 1999) and 0.31 keq/ha/yr for the aspen plots (Doram and Arp 2000). These values are somewhat higher than the interim generic critical loads adopted by CASA (1996) (Table 3). Since these modelling results were calculated using a more conservative base cation/aluminum (BC/Al) ratio than the European approach (6:1 versus 1:1), sensitive soils in the Oil Sands Region may have higher buffering capacities than related sensitive soils in Europe.

Abboud et al. (2002), using the Alberta Research Council (ARC) model, developed soil series-specific critical loads for the Alberta Oil Sands Environmental Research Program (AOSERP) soil mapping area.

2.3 TERRESTRIAL VEGETATION AND WETLANDS

Air emissions from oil sands operations that may affect the health of vegetation in the region include oxides of sulphur and nitrogen, which are precursors to acid inputs. These emissions can affect vegetation health, depending on concentrations, plant sensitivity and environmental conditions. The importance of nitrogen species as an air emission that may affect vegetation and wetlands has only been recently recognized.

While nitrogen contributes to acidification, at low concentrations it may also have a fertilizer effect (increase in growth) (Rochefort and Vitt 1988; Hutchinson and Meema 1987; Diekmann and Dupré 1997). However, this initial fertilizer effect may have deleterious effects in the long run, as the accumulation of nitrogen exceeds vegetation uptake capabilities, leading to nitrogen saturation and eutrophication (Diekmann and Dupré 1997; Thimounier et al. 1994; Rosen et al. 1992).

Changes in growth in regions of Northern European boreal forests were affected by long-term atmospheric input of acidifying and fertilizing compounds. Initially enhanced growth resulted, but deposition of sulphur and nitrogen compounds have led to decreased growth in more recent years (Nellemann and Thomsen 2001). Nutrient, physiological and mycorrhizal imbalances are also possible (Hanson and Turner 1992). Plants exposed to low levels of NO_X may have reduced tolerance of frost, drought, heat stress, insects and pathogens (Hutchinson and Meema 1987; Rosen et al. 1992; Fangmier et al. 1994). Forest decline has been greatest on poorly buffered soils (Ouimet et al. 2001).

Airborne emissions from oil sands developments can have both short- and long-term effects on vegetation vigour and health. Short-term exposure effects are usually restricted to a localized area and can include chlorosis or necrosis of plant tissues that can decrease growth rates, or eventually result in plant mortality. Long-term effects can occur over a much larger area and may result from the accumulation of chemicals in plant tissues, either by direct absorption into plant tissues from the air, or indirectly through deposition into the soil and into the roots. Once incorporated in the plant tissues, the chemicals can alter internal biochemical processes, and consequently can reduce productivity, vigour or health. Other chemicals (and dust) may be adsorbed onto the surface of plant tissues, reducing respiration and reception of radiation or photosynthesis, processes that may reduce plant vigour and productivity. Combinations of gases such as NO_2, SO_2 and ozone have also shown to be more harmful to vegetation than single gases (Torn et al. 1987).

2.3.1 Potential Effects

Potential effects to vegetation and wetlands may occur as a result of direct effects, indirect effects and/or secondary effects.

2.3.1.1 Direct Effects

Direct effects may result when plants absorb gases or liquids containing sulphur and/or other harmful compounds through their leaves. Direct effects may result in acute injury from exposure to relatively high concentrations for a short period of time (i.e., less than 24 hours), or chronic injury from exposure to relatively low concentrations over a long period of time (i.e., days, months or years) (Dreisinger and McGovern 1970).

While low-level deposition has shown to have a fertilizer effect, high levels of NO_2 air emissions have been shown to disrupt nutrient balances in plants. This may include leaching of essential nutrients such as magnesium and potassium and increased incidence of harmful metals such as aluminum (Wilson and Skeffington 1994; Slovik 1996; Rosen et al. 1992; Heinsdorf 1993; De Vries 1993).

Diagnosis of air pollutant stress based on visible symptoms can be difficult. Visible symptoms caused by air pollutants are not highly specific and often mimic symptoms caused by natural stress such as drought, excessive water, nutrient deficiency, diseases or insect infestation (Malhotra and Blauel 1980; Treshow 1984; Golder 2002).

2.3.1.2 Indirect Effects

Indirect effects are produced when acidifying emissions change the chemistry or biology of soil or water that, in turn, influences the amount and type of nutrients and toxic elements that may be taken up by plants. The most common problem is a reduction in soil pH, which changes nutrient availability (Hutchinson and Meema 1987). There is a delay period between soil alterations and vegetation responses to changes in soil chemistry (Diekmann and Dupré 1997). A soil sensitivity rating for acidic emissions is presented in Section 3.2.2.

Species abundance changes were first reported in Germany (Wittig and Neite 1985) and Sweden (Falkengren-Grerup 1986) in the 1980s. Økland et al. (2004) conducted more recent surveys that indicated the abundance of several vascular plants decreased significantly in spruce forest areas in Norway. They hypothesized that the vascular plant decline was due to the slow, delayed response of plants to the gradual soil acidification that has taken place during most of the 20th century. Vascular plant decline is a long-term trend and is apparently unresponsive to the reduced deposition (e.g., of sulphur) in more recent years. Soil acidification may still account for decreasing species abundances despite declining or ceased deposition of acidifying components. Two mechanisms may account for this: (1) lower growth and vitality of long-lived mature plants in more acid soils; and (2) lower seed germination and/or seedling survival in more acid soils.

Secondary effects are produced when stress or injury from air emissions predisposes plants to another source of stress or injury such as insect infestation, disease, drought or frost (World Health Organization (WHO) 2000; Rosen et al. 1992). Greater infestations of insect pathogens are documented for plants growing in atmospheres enhanced with SO_2 and NO_X (Hutchinson and Meema 1987). However, some degree of soil acidification may reduce incidence of disease (Gorham et al. 1984).

2.3.2 Responses of Plants to Air Emissions

Plant responses to air emissions depend on several factors. Factors can include dose, species sensitivity (sensitive versus resistant), plant development, time of year (dormancy versus active growth), atmospheric conditions (temperature, humidity and wind speed and direction), soil and nutrient status and time of day (gas exchange capability or open vs. closed stomata).

2.3.2.1 Dose-Response Relationships

Both concentration and length of exposure are important in determining potential effects of air emissions (Malhotra and Blauel 1980). In general, the higher the concentration of air emissions, the less time needed to see visible symptoms (both acute and chronic) (Legge 1995). However, other factors such as recovery time between exposures and frequency of exposure events are also important. For example, one large-scale event may not necessarily have a deleterious effect on vegetation, while longer exposures or short, intermittent exposures have both been found to cause chronic effects. The sensitivity of vegetation to air pollutants also increases with a history of exposure (Harvey and Legge 1979; Mansfield et al. 1987; Hutchinson and Meema 1987).

Plant responses can also affect dose-response relationships. For example, Mansfield et al. (1987) found that higher concentrations of SO_2 and NO_X caused less damage in some plants. They suggested that higher concentrations of airborne pollutants may cause stomatal closure, thereby reducing the actual dose received by the plant.

2.3.2.2 Single Species Sensitivity

Plants differ in their susceptibility to damage from emissions. This susceptibility is a function of plant type (vascular versus non-vascular), species and genotype. Lichens and mosses are considered the most sensitive plant groups to air emissions because they absorb all their nutrients from the air and rain water (Addison et al. 1986; Anderson and Treshow 1984; Baker 1980; Malhotra and Blauel 1980; Treshow 1984). In addition, trees with long life cycles suffer from long-term exposure, because subtle effects can build up year after year to produce harmful effects (WHO 2000; Hutchinson and Meema 1987). Deciduous species generally develop symptoms of stress to air emissions more rapidly than coniferous species (Malhotra and Blauel 1980; Addison et al. 1986). However, conifers, because of their long foliar retention time, can accumulate more contaminants than deciduous species that lose their leaves annually (Addison et al. 1986).

Lichens

Lichens have been extensively studied, especially in Europe, due to their high sensitivity to air emissions. This sensitivity is due to several factors, including:

- lack of a protective cuticle (which is found in higher plants);
- absorption of most nutrient requirements from the atmosphere (rather than the soil);
- presence of relatively less chlorophyll than in other plants; and
- inability of lichens to excrete toxic elements, coupled with efficient mechanisms for accumulating them (Hale 1974).

Hutchinson and Meema (1987) found that simulated rain (acid sprays) with a pH of 2.5 to 3.0 resulted in declines in percent cover as well as decreases in height, dry weight and net photosynthesis of surviving lichens. Interestingly, small decreases in rain pH (pH = 5.6 to 3.0) were found to stimulate growth; this is thought to be a result of the NO_X fertilizer effect.

General statements can be made about sensitivity of various lichen types. Growth form appears to be an important predictor of sensitivity; crustose has been found to be most resistant to air pollution, while foliose and fruiticose lichens are more sensitive (Hale 1974; Nriagu 1978). Generally, soil-inhabiting lichens are less sensitive than corticolous lichens, while saxicolous (rock-inhabiting) lichens sensitivity is somewhat dependent on substrate (Hale 1974). In addition, sensitivity is also dependent on species and genotype (Hutchinson and Meema 1987).

In the Oil Sands Region, corticolos lichens are most frequently encountered, particularly *Usnea* and *Bryoria* spp., which typically occur on coniferous trees in open jack pine stands or more commonly, the black spruce bogs and fens that dominant the region. Fruticose lichens, such as *Cladina mitis* and *Cladina rangiferina* are also quite abundant, particularly in dry, open jack pine stands or dry, black spruce bogs. Foliose lichens, such as *Parmelia sulcata* are also quite common throughout the region and can be found growing on both deciduous and coniferous trees in a wide variety of ecosystems.

Mosses (Bryophytes)

Mosses have also been identified as particularly sensitive to acidifying emissions. Like lichens, mosses lack a cuticle. Experiments carried out by Hutchinson and Meema (1987) found that feather moss (*Pleurozium schreberi*) was especially sensitive to acidic rains in the boreal forest, while lichens are somewhat less sensitive. Severe effects on feather moss were found at pH less than 3.5, with pH 2.5 causing almost complete elimination of the feather moss mat. All acidic inputs (pH less than 5.6) were found to deplete calcium and magnesium in shoot tips (Hutchinson and Meema 1987).

However, as with lichens, low levels of acidifying emissions have been found to have a fertilizer effect on some species of mosses such as brown mosses (Bayley et al. 1987; Hutchinson and Meema 1987; Rochefort and Vitt 1988). Brown mosses are typically found on hummocks and are often nutrient limited. Small decreases in pH may not have a deleterious effect, if NO_X is, at least partially, the source of this decreased pH. This is because the NO_X acts as a nitrogen source, particularly in oligotrophic environments where nitrogen may be limiting. If pH decreases further, any fertilizer effect is outweighed by the damage caused by low pH (Rochefort and Vitt 1988). Both long-term exposure to acidic deposition and supra-optimal levels of nitrate have been cited as the cause of the virtual disappearance of Sphagnum species from bogs in the southern Pennines of England (Bayley et al. 1987; Hutchinson and Meema 1987). As with lichens, other air emissions such as particulates may affect mosses (Pauls et al. 1996).

Mosses such as *Sphagnum* and brown moss species have been found to control the distribution of nitrogen, thus limiting nutrients in bogs and fens (peat forming wetlands) (Li and Vitt 1997). The capability of these mosses to sequester and retain nitrogen and other limiting nutrients aid in the sequestration of carbon and inhibit the decomposition, thus enabling the formation of peat. Li and Vitt (1997) suggest that nitrogen saturation from deposition may inhibit the ability of moss to regulate nitrogen distribution in peatlands. The result of excess nitrogen is increased decomposition that would damage the capability of these wetlands to form peat.

Trees, Shrubs and Herbaceous Species

Several trees have been identified as sensitive to acidifying emissions based on laboratory, field and ecosystem studies. Table 4 presents plant sensitivities based on a literature review. Although some evidence suggests that herbaceous species have a higher rate of recovery to air emissions exposure than woody species, the information on shrub and herbaceous species is incomplete (Mansfield et al. 1987).

Table 4 Plant Sensitivity to Acidifying Emissions

Common Name	Species Name	Ranking
Trees		
jack pine	*Pinus banksiana*	high(a)
paper birch	*Betula papyrifera*	high(a)
trembling aspen	*Populus tremuloides*	high(a)
balsam fir	*Abies balsamea*	medium(a,b)
white spruce	*Picea glauca*	medium(a,b)
balsam poplar	*Populus balsamifera*	low(a)
black spruce	*Picea mariana*	unknown
tamarack	*Larix laricina*	unknown
Shrubs		
green alder	*Alnus crispa*	high(g,h,i)
river alder	*Alnus tenuifolia*	high(g,h,i)
prickly rose	*Rosa acicularis*	medium(a,h)
willow	*Salix spp*	medium(g,h,i)
beaked hazelnut	*Corylus cornuta*	medium(h)
bog bilberry	*Vaccinium uliginosum*	medium(h)
Canada buffalo berry	*Sherperdia canadensis*	medium(h)
common snowberry	*Symphoricarpos albus*	medium(h)
pin cherry	*Prunus pennysylvanica*	medium(h)
raspberry	*Rubus ideaus*	medium(h)
saskatoon	*Amelancher alnifolia*	medium(h)
blueberry	*Vaccinium myrtilloides*	medium(h,j)
chokecherry	*Prunus virginiana*	medium(h,j)
red-osier dogwood	*Cornus stolonifera*	medium(h,m)
currant	*Ribes spp.*	medium(j,l)
bearberry	*Arctostaphylos uva-ursi*	tolerant(j)
Labrador tea	*Ledum groenlandicum*	tolerant(o)
Forbs		
fireweed	*Epilobium angustifolium*	high(h,n)
bunchberry	*Cornus canadensis*	high(k)
aster	*Aster spp.*	medium(h)
cloudberry	*Rubus chamaemorus*	medium(h)
creamy peavine	*Lathyrus ochrolsucus*	medium(h)
dewberry	*Rubus pubescens*	medium(h)
sarsaparilla	*Aralia nudicaulis*	medium(h)
violet	*Viola spp.*	medium(h)
Mosses		
brown moss	*Drepanocladue spp.*	high(a)

Table 4 Plant Sensitivity to Acidifying Emissions (continued)

Common Name	Species Name	Ranking
feather moss	*Pleurozium schreberi*	high[(a)]
knight's plume	*Ptilium crista-castrensis*	high[(a)]
stair-step moss	*Hyloconium splendens*	high[(a)]
golden moss	*Tomenthypnum nitens*	variable[(a,c)]
peat moss	*Sphagnum spp.*	variable[(a,d,e)]
Lichens		
lichen	*Cladina spp.*	high[(a,b,f)]
lichen	*Stereocaulon lividum*	high[(a,b,f)]
reindeer lichen	*Cladina spp.*	high[(a,b,f)]

(a) = Linzon (1978); (b) = Treshow (1984); (c) = Rochefort and Vitt (1988); (d) = Bayley et al. (1987); (e) = Hutchinson and Meema (1987); (f) = Hale (1974); (g) = Dreisinger and McGovern (1970); (h) = Legge 1998, pers. comm.; (i) = Malhorta and Blauel (1980); (j) = Davis and Wilhour (1976); (k) = Huttenen (1984) in Treshow (1984); (l) = Linzon (1972); (m) = Treshow (1970); (n) = Hocking (1975); (o) = Addison et al. (1986).

2.3.2.3 Relative Sensitivity and Shifts in Species Composition

Air emissions may act as a selective pressure both within species and between species due to the relative sensitivity of different genotypes and species (Hutchinson and Meema 1987). Discussions of shifts in genotype frequency are beyond the scope of this discussion. Shifts in species composition and dominance could have an important effect on plant communities. Several examples exist, as discussed below.

In a study conducted by Malhotra and Khan (1984) there was a decline in some tree species adjacent to the emission source studied. In particular, white spruce, black spruce and aspen were not observed within a 15-km radius. Furthermore, eastern white pine was not observed within a 50-km radius of the plant. This study suggests that tree species have varying tolerances to air emissions, eastern white pine being the most sensitive.

Monitoring of change in single species abundance, species number and species composition in Norwegian boreal forests confirms previous assumptions that the forest understorey vegetation contains a large set of indicators sensitive to changes in environmental conditions (Økland et al. 2004). The complexity of forest decline in relation to air pollution suggests that the combined actions of eutrophication, acidification and climatic change/stress, rather than single mechanisms such as aluminum toxicity, are responsible for the observed pattern in growth changes (Nellemann and Thomsen 2001).

2.3.2.4 Nitrogen Deposition

The importance of nitrogen deposition as a component of acid has only been recognized recently. Nitrogen emissions from oil sands operations may contribute to elevated nutrient loading of the surrounding environment. Nitrogen deposition is derived from all gaseous species of elemental nitrogen and combines dry (gas or particles) and wet (dissolved ions) deposition. Loss of Sphagnum species from bogs in the United Kingdom has been attributed to long-term exposure to extreme acidic deposition (Bayley et al. 1987; Gorham et al. 1984; Hutchinson and Meema 1987). Yet where nitrogen is limiting, acid deposition may increase production (De Vries 1993). A recent study in the Oil Sands Region has determined that nitrogen deposition levels in the region stimulate production of rusty peat moss (*Sphagnum fuscum*) in ombrogeneous bogs (Vitt et al. 2002).

Vitt et al. (2002) measured the growth of rusty peat moss on a nitrogen deposition gradient in the Oil Sands Region. Growth of rusty peat moss in a Steepbank River bog, located near oil sands mining activity, was significantly higher than in other plots studied. Nitrogen accumulation over time was generally found to be higher in high nitrogen deposition sites than in low nitrogen deposition sites.

While nitrogen contributes to acidification, at low concentrations it may also cause an increase in growth (fertilizer effect) (Rochefort and Vitt 1988; Hutchinson and Meema 1987; Diekmann and Dupré 1997). Vitt et al. (2002) found that nitrogen concentrations in Sphagnum were found to be significantly lower in the Steepbank River bog than in the other sites studied. This is related to the more rapid production at this site. "As *Sphagnum fuscum* is growing at a more rapid pace, the amount of time that any part of the plant is exposed to the atmosphere will be lower, hence even though nitrogen deposition is higher, the cumulative amount of nitrogen that any given part of the plant will be exposed to is lower" (Vitt et al. 2002).

Increased vegetation production from oil sands activities may disrupt vegetation community balances and cause shifts from plants preferring a nitrogen-poor environment to those that perform better in a nitrogen-rich environment (De Vries 1993). Increased nitrogen deposition was shown to cause a shift in the grass and herb layer towards nitrophilic species in heathland vegetation communities (De Vries 1993). The most susceptible ecosystems included oligotrophic wetlands and heathlands with high lichen cover.

2.3.2.5 Ecosystem Sensitivity

The number of ecosystem sensitivity studies is limited. Legge (1995) identifies two studies at Trail, British Columbia and Sudbury, Ontario. Existing data indicate that species occurring in natural ecosystems are less sensitive to emissions than greenhouse or laboratory species (Nriagu 1978).

Terrestrial Ecosystems

Study of acidifying emissions and terrestrial ecosystems has largely focused on agro-ecosystems and forest ecosystems. Generally, studies focus on specific sensitive species and make few conclusions with regard to sensitive community types or ecosystems. However, several studies have focused on general trends observed in areas of forest dieback.

Air emissions, including acidifying emissions and ozone, have been identified as a factor in large-scale forest dieback in northern Europe and the northeastern United States (Hutchinson and Meema 1987). Studies have focused on nutrient deficiency as a primary cause of forest decline. Hutchinson and Meema (1987) found that leaf colour changes that precede early abscission and premature tree death were the result of nutrient deficiency. Specifically, foliar concentrations of magnesium, calcium and potassium were found to be low in affected trees. Acidifying emissions have been identified as a possible cause of nutrient leaching and subsequent deficiency in foliar tissue. Furthermore, replacement of nutrients in leached foliar tissue is limited by changes in nutrient availability in increasingly acidic soil.

Acidic inputs may also affect tree root systems, causing them to move closer to the soil surface. This could increase susceptibility to drought and blow-downs (A. Legge 1998, Pers. Comm.).

As such, forest ecosystems with nutrient-poor soils have been identified as particularly sensitive to acidifying emissions (Hutchinson and Meema 1987).

Wetlands Ecosystems

The impact of acidifying emissions on peatlands has been discounted in the past, as the naturally acidic ecosystems were deemed “resistant” to acidic emissions. Gorham et al. (1984), as cited in Hutchinson and Meema (1987), found sensitivity of peatlands to acidic inputs depends upon the level of buffering within the peatland.

Wetlands can be subdivided into mineral wetlands and peatlands based on annual peat accumulation. Peatlands are defined as a wetlands ecosystem depositing more than 30 cm of peat and include fens and bogs (Gorham et al. 1984). Peatlands systems can be further subdivided into rich fens, poor fens and bogs. Fens are minerotrophic, receiving mineral-rich water from groundwater sources; with rich fens being relatively more minerotrophic/nutrient rich than poor fens. Bogs are ombrotrophic, receiving water and nutrients from rain water only; as such they are relatively nutrient poor. Rich fens are high in base ions and thus, have relatively high alkalinity. Humic substances and aluminum species buffer bogs. As such, both rich fens and bogs are thought to be relatively resistant to acidic inputs. In contrast, poor fens, whose surface waters have low alkalinity, are at about pH 6. They are wholly organic with very little input of silt and are expected to be susceptible to acidification (Gorham et al. 1984).

Rapid change in pH in unbuffered fens has not been documented. However, natural peatland succession from fens to bogs, with accompanying rapid changes in pH, can be inferred from the bimodal frequency distribution of pH in peatlands. A study of peatlands in Minnesota shows the bog mode at pH 4 and fen mode at pH 6, with relatively few sites in the intermediate range (Hutchinson and Meema 1987). With these shifts in pH come shifts in species composition and abundance.

The invasion of vulnerable fens by Sphagnum species as pH decreases has been identified as a potentially serious effect of acidification. As Sphagnum species produce organic (polyuronic) acids, invasion by Sphagnum would likely result in additional acidification (Hutchinson and Meema 1987). The effect of acid deposition may be to accentuate this process, stimulating the transition of fens to bogs (Vitt 1994).

Recent studies have found that peatlands are somewhat resistant to acidic inputs. Gorham et al. (1984) found that peatlands were more efficient sinks for sulphate, nitrate and hydrogen ions than other terrestrial ecosystems studied. Bayley et al. (1987) found that monthly acid additions to a poor fen in northwestern Ontario over two growing seasons did not result in any long-term changes (i.e., more than 14 days) in nitrate, sulphate or pH. They concluded that over the year-and-a-half study, the poor fen acted as a sink for SO_4^{2-} and NO_3^-. However, they also found that the growth of acidophilic Sphagnum increased, especially in oligotrophic micro-environments (i.e., hummock-tops that are isolated from groundwater). This increase in growth was largely attributed to the fertilizer effect of nitrogen input.

The presence of permafrost can influence the effect of acidic emissions. Peatlands where permafrost is present may be less affected by acidic deposition as permafrost restricts the volume of peat accessible to acidic deposition (Gorham et al. 1984).

Other Factors

Plants are constantly exposed to natural stresses such as drought, excessive water, nutrient deficiency, disease or insect infestation. Among the many natural stresses that plants experience, acidifying emissions are probably minor (Forest Soils Group Summary in Hutchinson and Meema 1987). Studies of forest dieback in Europe and the northeastern United States suggest that severe and prolonged drought followed by a colder than normal winter may have initiated large-scale forest dieback in certain areas (Forest Soils Group Summary in Hutchinson and Meema 1987). However, the effects of acidification may cause forest ecosystems to be more sensitive to other stresses (Hutchinson and Meema 1987).

2.4 WILDLIFE AND WILDLIFE HABITAT

Air emission effects on wildlife can be either direct or indirect. Both pathways are discussed in this section.

2.4.1 Direct Effects

Wildlife may be exposed to air emissions by direct inhalation. The majority of potentially toxic chemicals released from air emissions are volatile but will not deposit to an appreciable extent on to soil and plants. Incomplete combustion may release small amounts of Polycyclic Aromatic Hydrocarbons (PAHs). These compounds may reduce the amount or quality of wildlife habitat or may affect wildlife health. The potential direct effects of air emissions on wildlife health are assessed in Appendix 3-VI.

2.4.2 Indirect Effects

Particulate matter containing low concentrations of PAHs may deposit directly onto plant surfaces and soils in the area and can be taken up into plants. Wildlife health may be affected from foraging on plants that have higher concentrations of these compounds. Further discussion on this pathway can be found in Section 3.4.4.

Air emissions from the Project will contain sulphur dioxide and nitrogen oxide. These chemicals can return to the ground as acid deposition, which can reduce the pH of lakes and streams. Acidic lakes and streams have the potential to reduce productivity of amphibians, such as the Canadian toad. These potential effects are also discussed in Section 3.4.4.

The effects of acid deposition on lichens are a potential issue, as lichen is an important food for woodland caribou. Lichen abundance and/or diversity can be adversely affected by high concentrations of SO_2. Annual average SO_2 concentrations above 39.3 µg/m³ (0.15 ppm) have been shown to result in reductions in lichens and bryophytes (Linzon 1978). When annual average SO_2 concentrations exceeded 41.9 µg/m³ (0.016 ppm), very low diversities of lichen and bryophyte species were observed. While the annual Alberta Ambient Air Quality Objectives (AAAQO) for SO_2 is 30 µg/m³, the WHO considers that 10 µg/m³ provides adequate protection for lichens.

3 REVIEW OF MONITORING OF AIR EMISSIONS EFFECTS IN THE OIL SANDS REGION

3.1 AQUATIC RESOURCES

Acid-sensitive lakes within the Oil Sands Region have been sampled as part of environmental impact assessments, monitoring programs for oil sands developments and the Regional Aquatics Monitoring Program (RAMP), which includes annual sampling of 50 acid-sensitive lakes in the region (RAMP 2005).

Statistical trend analysis was conducted as part of the 2005 RAMP Report for individual lakes. A Mann-Kendall trend analysis was preformed on all parameters related to the effects of acid deposition. This analysis found that while base cations did show a significant decrease in some of the lakes, there was no evidence to conclude that there have been any significant changes in the lake chemistry over the period with available RAMP data (1999 to 2005).

To provide an overview of RAMP results available to date, the 50 RAMP lakes were grouped by region and box and whisker plots were prepared to qualitatively evaluate trends in alkalinity (Figures 3 to 8) and pH (Figures 9 to 14). The lakes included in each region are shown in Table 5. Medians and percentiles were calculated assuming a lognormal distribution for alkalinity and a normal distribution for pH. Data collected by RAMP between 1999 and 2005 were used. As also shown by the 2005 RAMP trend analysis, plots of alkalinity and pH indicate that these parameters were stable over the period assessed.

Table 5 Lakes Included in Regional Groups

Lake ID	Nox-Sox GIS Number[(a)]	RAMP Lake ID	Sub-Region[(b)]
115	168	A21	Stoney Mountains
116	169	A24	Stoney Mountains
117	170	A26	Stoney Mountains
118	167	A29	Stoney Mountains
122	166	A86	Stoney Mountains
143	287	25	Stoney Mountains
144	289	27	Stoney Mountains
145	290	28	Stoney Mountains
146	342	82	Stoney Mountains
147	354	94	Stoney Mountains
119	165	A42	West of Fort McMurray
120	171	A47	West of Fort McMurray
121	172	A59	West of Fort McMurray
153	223	P94	West of Fort McMurray
154	225	P96	West of Fort McMurray
155	226	P97	West of Fort McMurray

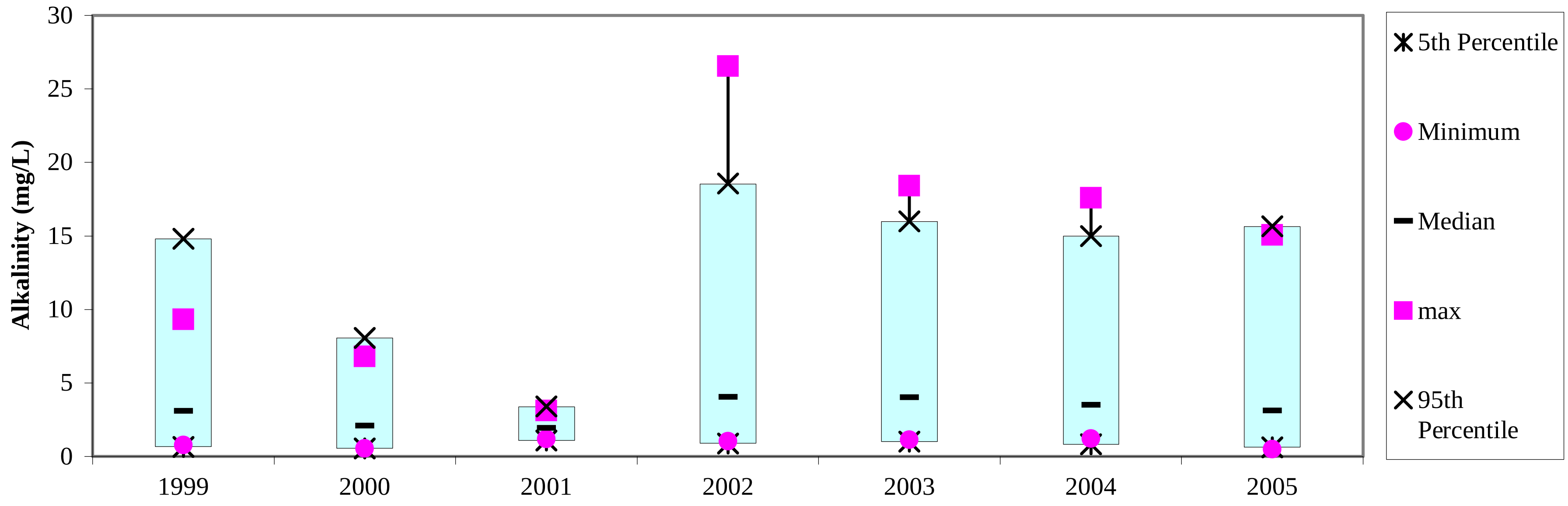
Table 5 Lakes Included in Regional Groups (continued)

Lake ID	Nox-Sox GIS Number[a]	RAMP Lake ID	Sub-Region[b]
156	227	P98	West of Fort McMurray
134	267	1	West of Fort McMurray
82	452	L4	Northeast of Fort McMurray
83	470	L7	Northeast of Fort McMurray
84	471	L8	Northeast of Fort McMurray
105	400	L39	Northeast of Fort McMurray
129	268	E15	Northeast of Fort McMurray
149	182	P23	Northeast of Fort McMurray
150	185	P27	Northeast of Fort McMurray
152	209	P7	Northeast of Fort McMurray
141	270	4	Northeast of Fort McMurray
142	271	6	Northeast of Fort McMurray
4	418	Kearl L.	Northeast of Fort McMurray
91	436	L18	Birch Mountains
92	442	L23	Birch Mountains
93	444	L25	Birch Mountains
96	447	L28	Birch Mountains
97	448	L29	Birch Mountains
106	454	L46	Birch Mountains
100	455	L47	Birch Mountains
101	457	L49	Birch Mountains
107	464	L60	Birch Mountains
148	175	P13	Birch Mountains
151	199	P49	Birch Mountains
162	473	A301	Canadian Shield
112	118	L107	Canadian Shield
114	84	L109	Canadian Shield
160	88	O-10	Canadian Shield
157	90	R1	Canadian Shield
123	146	E52	Caribou Mountains
125	152	E59	Caribou Mountains
128	89	E68	Caribou Mountains
124	91	O-1/E55	Caribou Mountains
127	97	O-2 E67	Caribou Mountains

(a) Lake identifier used in the 2004 RAMP technical report (RAMP 2005).

(b) Lakes in the Canadian Shield area and in the Caribou Mountains were not included in the assessment because they are outside the Air Quality Modelling Domain and do not appear in Figure 4.2-1 in the Air Emission Effects Assessment. They are shown in Figure 6.6-9 of the 2004 RAMP technical report (RAMP 2005).

L:\2007\1346 Oil Sands\07-1346-0009-MEG EXPANSION\8200\8220\Fig 3 Alkalinity of Lakes in the Stony Mountain Region (10 Lakes).dwg Apr 12, 2008 - 2:51pm



PROJECT

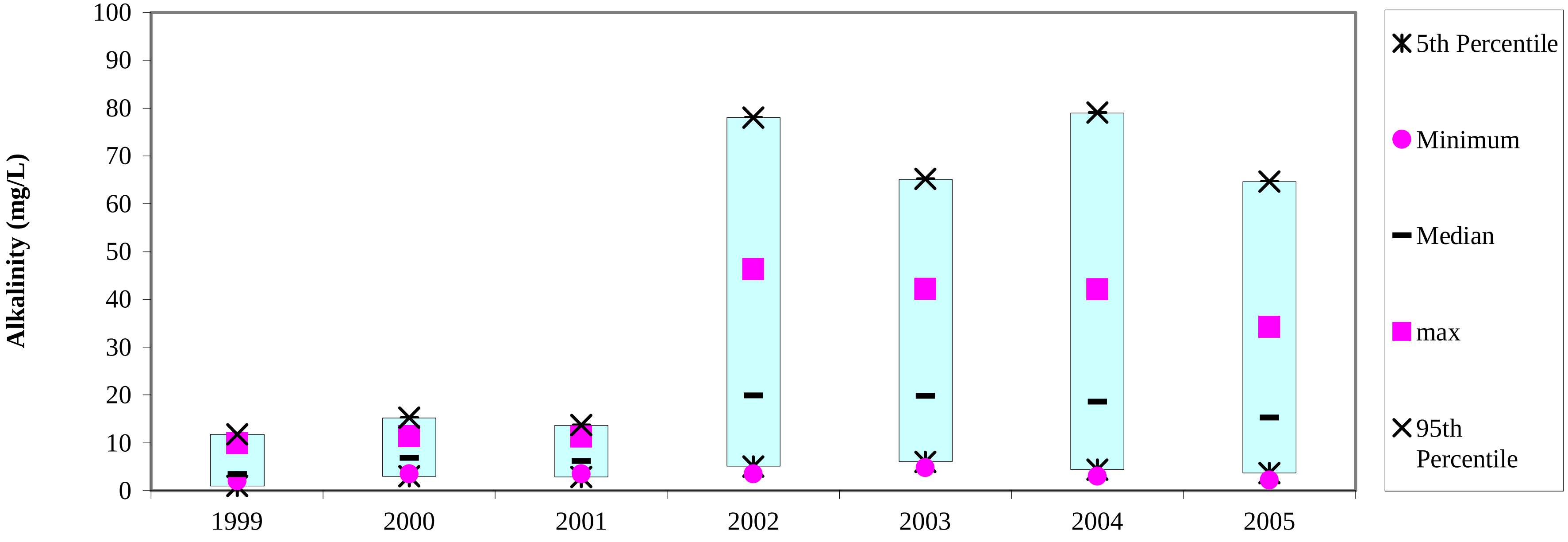
CHRISTINA LAKE REGIONAL PROJECT - PHASE 3

TITLE

ALKALINITY OF LAKES IN THE STONY MOUNTAIN REGION (10 LAKES)

MEG ENERGY CORP.

PROJECT	07.1346.0009.8200		FILE No.	Alkalinity of Lakes
DESIGN	TR	03/04/08	SCALE AS SHOWN	REV. 0
CADD	PSR	03/04/08		
CHECK	TR	08/04/08	FIGURE: 3	
REVIEW	IGG	11/04/08		



PROJECT

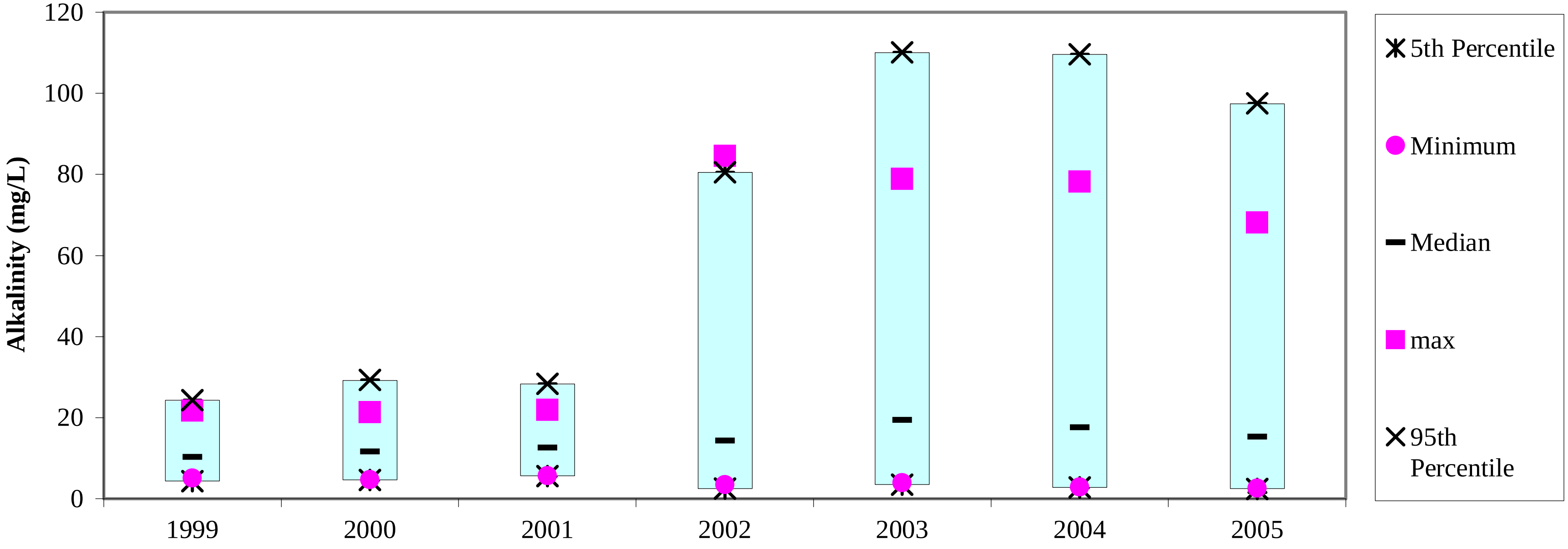
CHRISTINA LAKE REGIONAL PROJECT - PHASE 3

TITLE

ALKALINITY OF LAKES IN THE REGION WEST OF FORT McMURRAY (8 LAKES)

MEG ENERGY CORP.

PROJECT	07.1346.0009.8200		FILE No.	Alkalinity of Lakes
DESIGN	TR	03/04/08	SCALE AS SHOWN	REV. 0
CADD	PSR	03/04/08		
CHECK	TR	08/04/08	FIGURE: 4	
REVIEW	IGG	11/04/08		



PROJECT

CHRISTINA LAKE REGIONAL PROJECT - PHASE 3

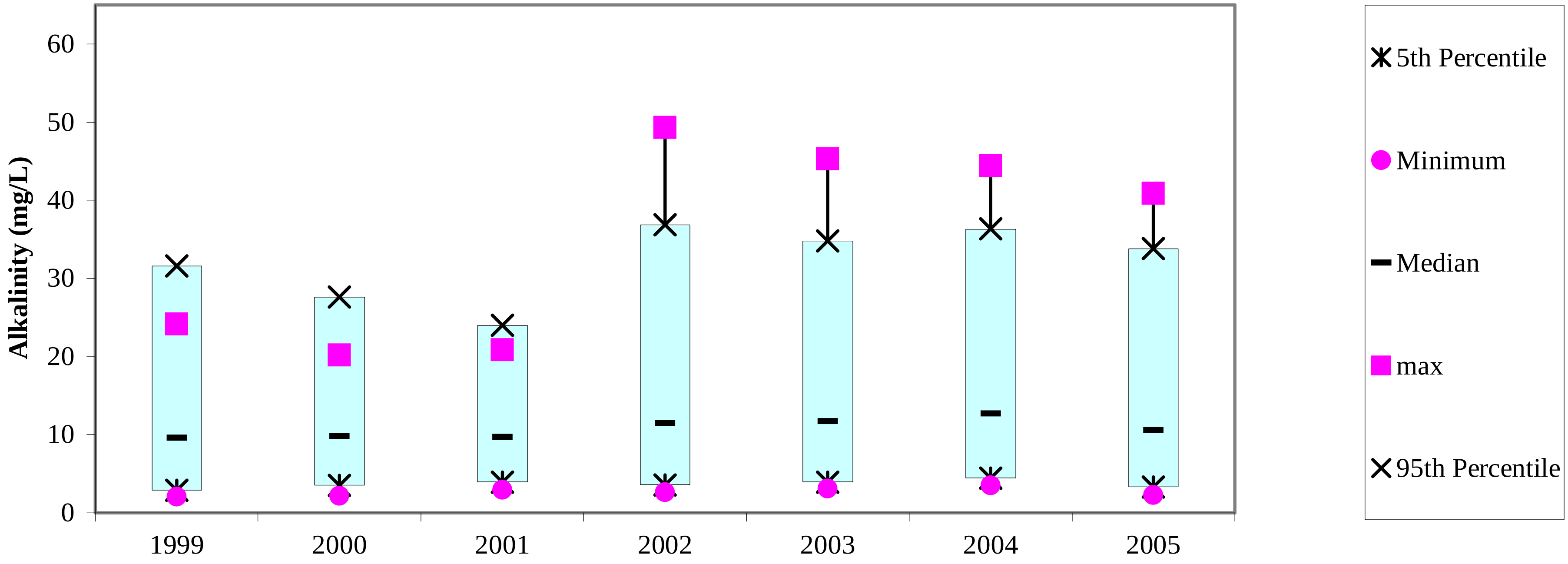
TITLE

ALKALINITY OF LAKES IN THE REGION NORTHEAST OF FORT McMURRAY (11 LAKES)

MEG ENERGY CORP.

PROJECT	07.1346.0009.8200		FILE No.	Alkalinity of Lakes
DESIGN	TR	03/04/08	SCALE AS SHOWN	REV. 0
CADD	PSR	03/04/08		
CHECK	TR	08/04/08	**FIGURE: 5**	
REVIEW	IGG	11/04/08		

L:\2007\1346 Oil Sands\07-1346-0009-MEG EXPANSION\8200\8220\Fig 6 Alkalinity of Lakes in the Birch Mountain Region (11 Lakes).dwg Apr 12, 2008 - 2:55pm



PROJECT

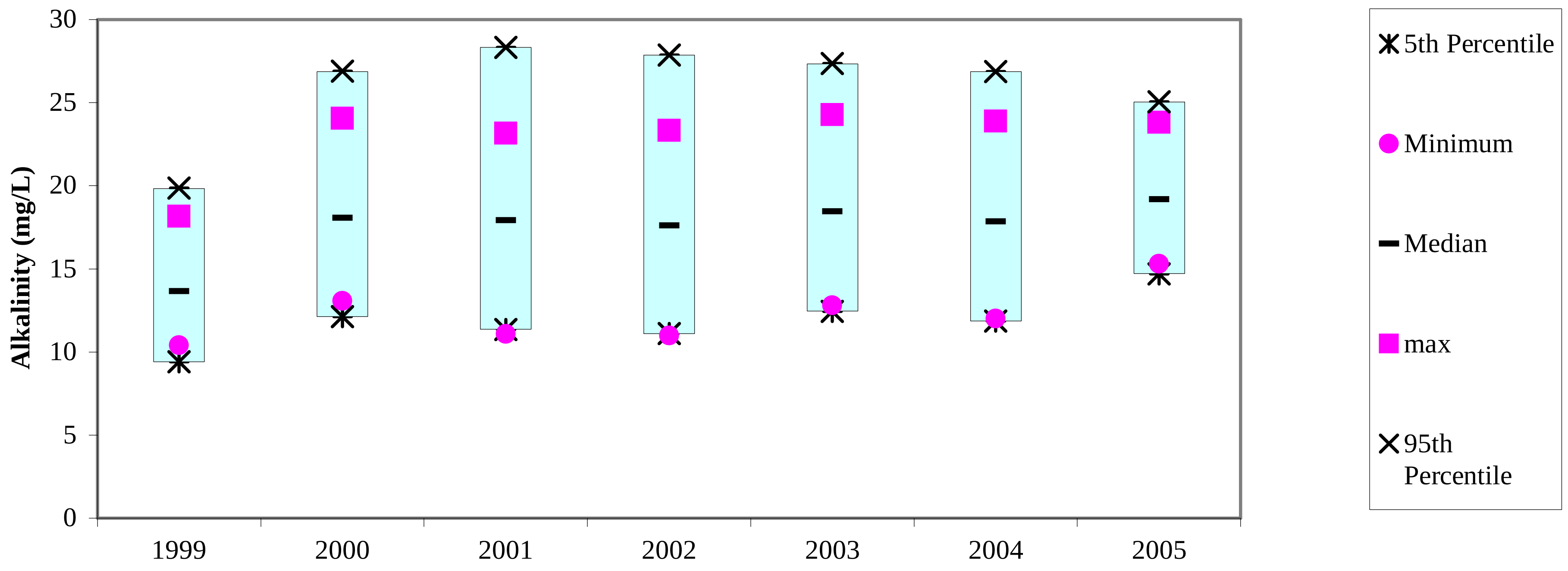
CHRISTINA LAKE REGIONAL PROJECT - PHASE 3

TITLE

ALKALINITY OF LAKES IN THE BIRCH MOUNTAIN REGION (11 LAKES)

MEG ENERGY CORP.

PROJECT	07.1346.0009.8200		FILE No.	Alkalinity of Lakes
DESIGN	TR	03/04/08	SCALE AS SHOWN	REV. 0
CADD	TRE	03/04/08	**FIGURE: 6**	
CHECK	TR	08/04/08		
REVIEW	IGG	11/04/08		



PROJECT

CHRISTINA LAKE REGIONAL PROJECT - PHASE 3

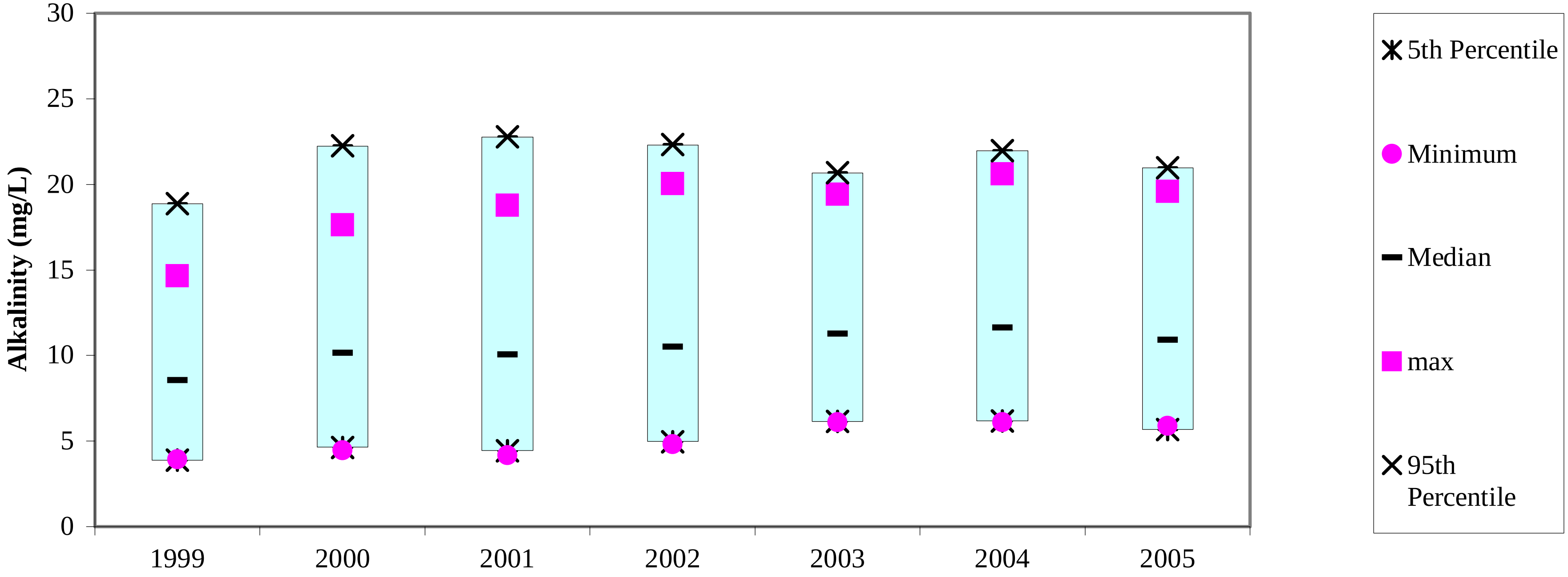
TITLE

ALKALINITY OF LAKES IN THE CANADIAN SHIELD REGION (5 LAKES)

MEG ENERGY CORP.

PROJECT	07.1346.0009.8200		FILE No.	Alkalinity of Lakes
DESIGN	TR	03/04/08	SCALE AS SHOWN	REV. 0
CADD	TRE	03/04/08	**FIGURE: 7**	
CHECK	TR	08/04/08		
REVIEW	IGG	11/04/08		

L:\2007\1346 Oil Sands\07-1346-0009-MEG EXPANSION\8200\8220\Fig 8 Alkalinity of Lakes in the Caribou Mountain Region (5 Lakes).dwg Apr 12, 2008 - 2:58pm



PROJECT

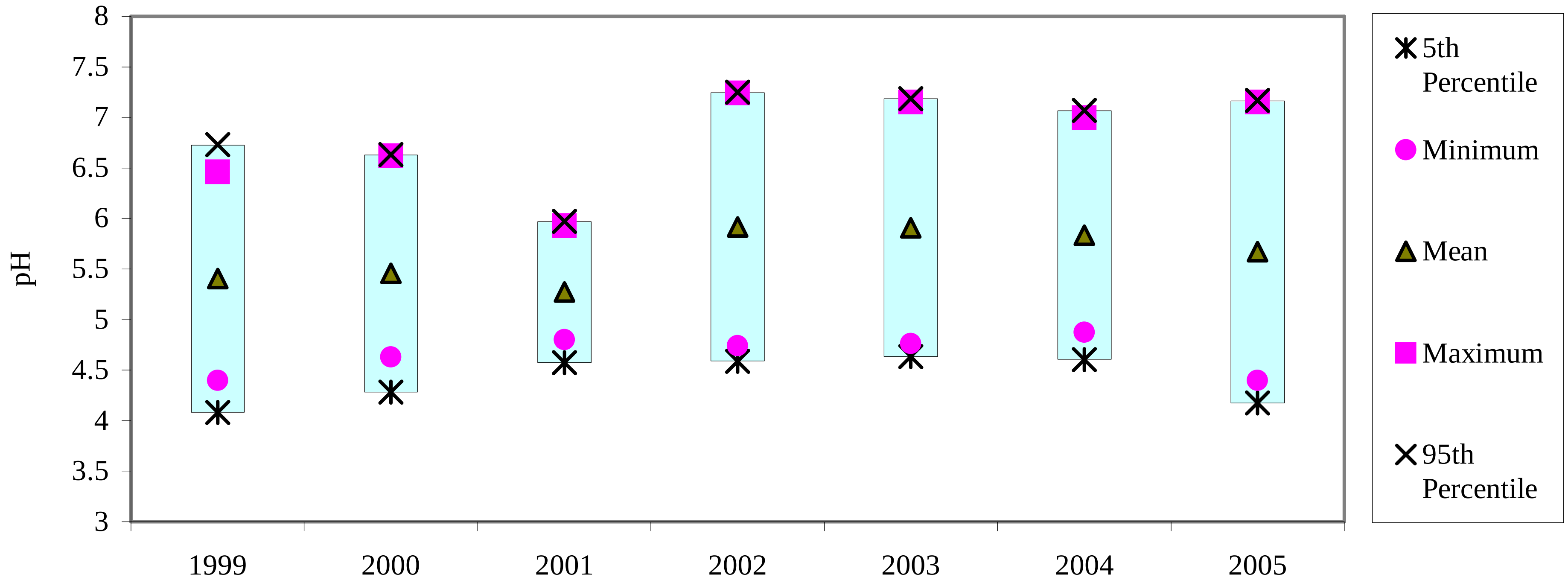
CHRISTINA LAKE REGIONAL PROJECT - PHASE 3

TITLE

ALKALINITY OF LAKES IN THE CARIBOU MOUNTAIN REGION (5 LAKES)

MEG ENERGY CORP.

PROJECT	07.1346.0009.8200		FILE No.	Alkalinity of Lakes
DESIGN	TR	03/04/08	SCALE AS SHOWN	REV. 0
CADD	TRE	03/04/08		
CHECK	TR	08/04/08	**FIGURE: 8**	
REVIEW	IGG	11/04/08		



PROJECT

CHRISTINA LAKE REGIONAL PROJECT - PHASE 3

TITLE

pH OF LAKES IN THE STONY MOUNTAIN REGION (10 LAKES)

MEG ENERGY CORP.

PROJECT	07.1346.0009.8200		FILE No.	pH of Lakes
DESIGN	TR	03/04/08	SCALE AS SHOWN	REV. 0
CADD	TRE	03/04/08	**FIGURE: 9**	
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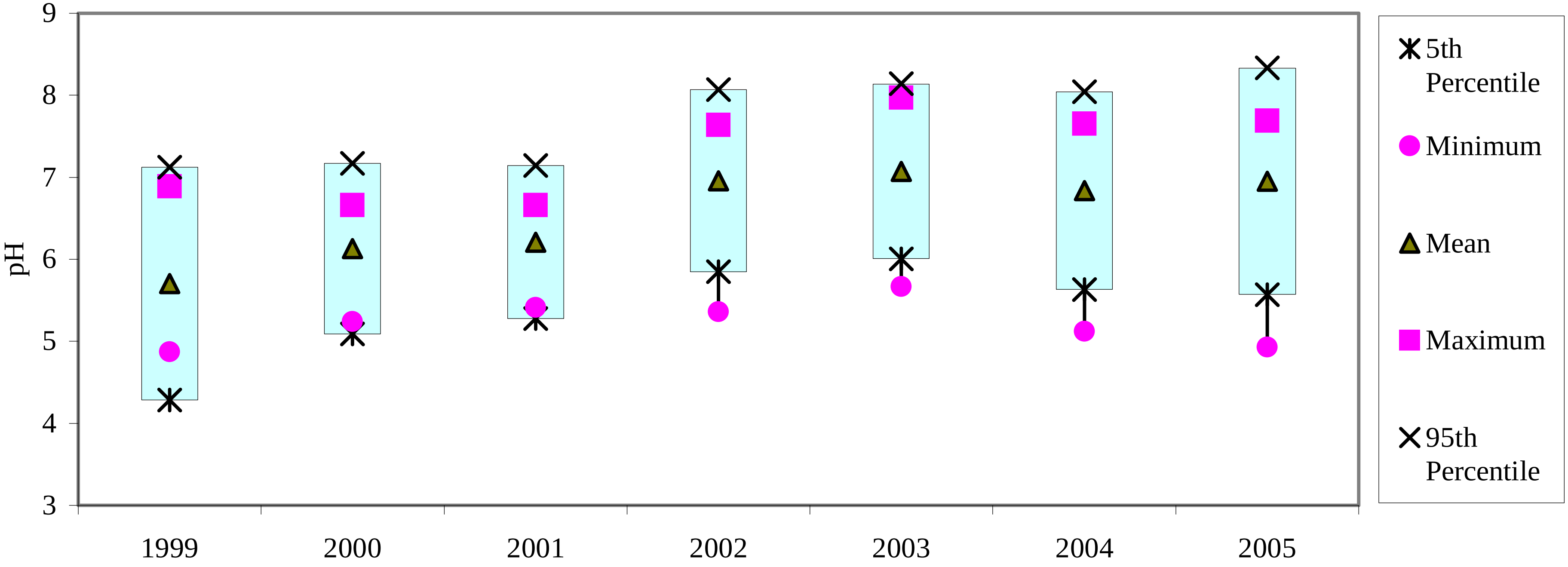


PROJECT

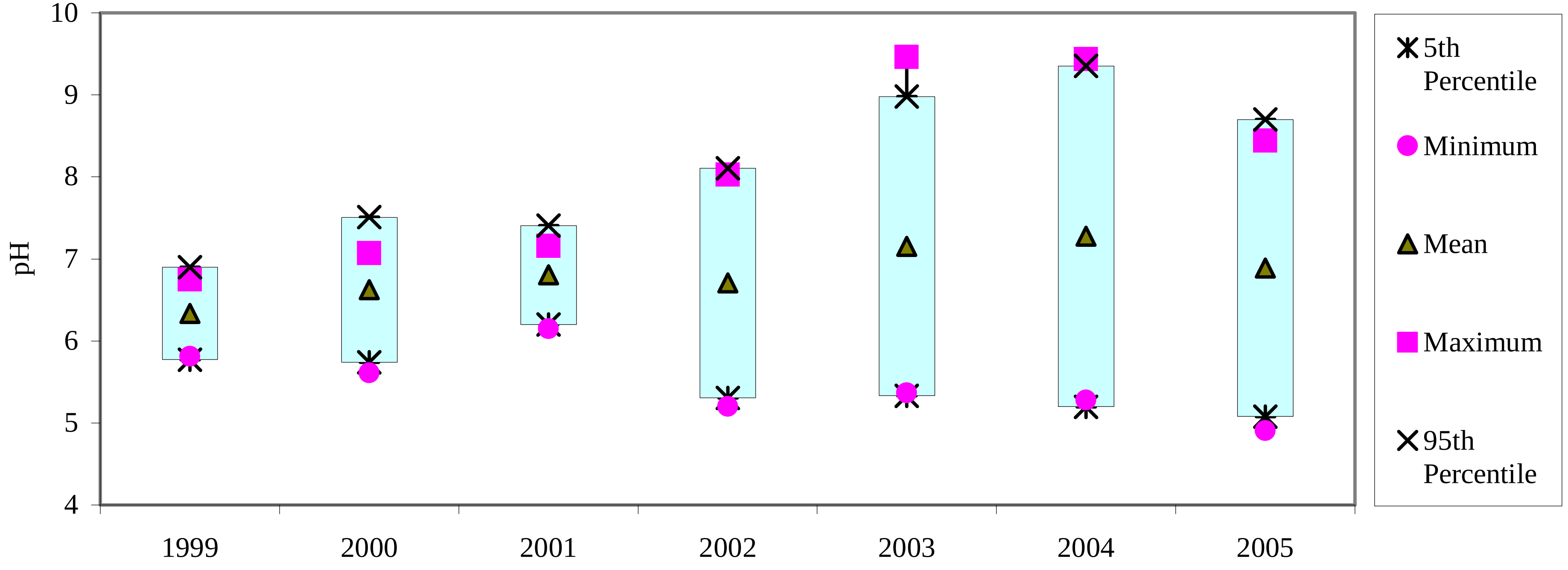
CHRISTINA LAKE REGIONAL PROJECT - PHASE 3

TITLE

pH OF LAKES IN THE REGION WEST OF FORT McMURRAY (8 LAKES)

MEG ENERGY CORP.

PROJECT	07.1346.0009.8200		FILE No.	pH of Lakes
DESIGN	TR	03/04/08	SCALE AS SHOWN	REV. 0
CADD	TRE	03/04/08	**FIGURE: 10**	
CHECK	TR	08/04/08		
REVIEW	IGG	11/04/08		



PROJECT

CHRISTINA LAKE REGIONAL PROJECT - PHASE 3

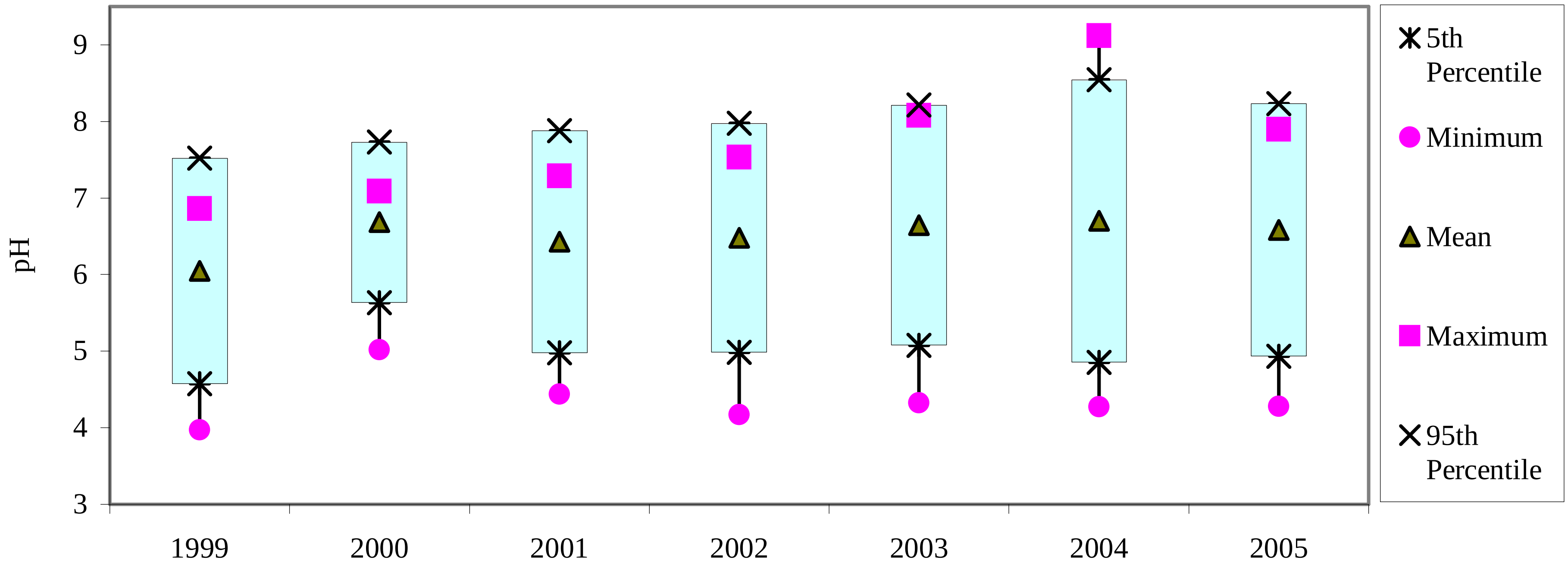
TITLE

pH OF LAKES IN THE REGION NORTHEAST OF FORT McMURRAY (11 LAKES)

MEG ENERGY CORP.

PROJECT	07.1346.0009.8200		FILE No.	pH of Lakes
DESIGN	TR	03/04/08	SCALE AS SHOWN	REV. 0
CADD	TRE	04/04/08	**FIGURE: 11**	
CHECK	TR	08/04/08		
REVIEW	IGG	11/04/08		

L:\2007\1346 Oil Sands\07-1346-0009-MEG EXPANSION\8200\8220\Fig 12 pH of Lakes in the Birch Mountain Region (11 Lakes).dwg Apr 12, 2008 - 3:10pm



PROJECT

CHRISTINA LAKE REGIONAL PROJECT - PHASE 3

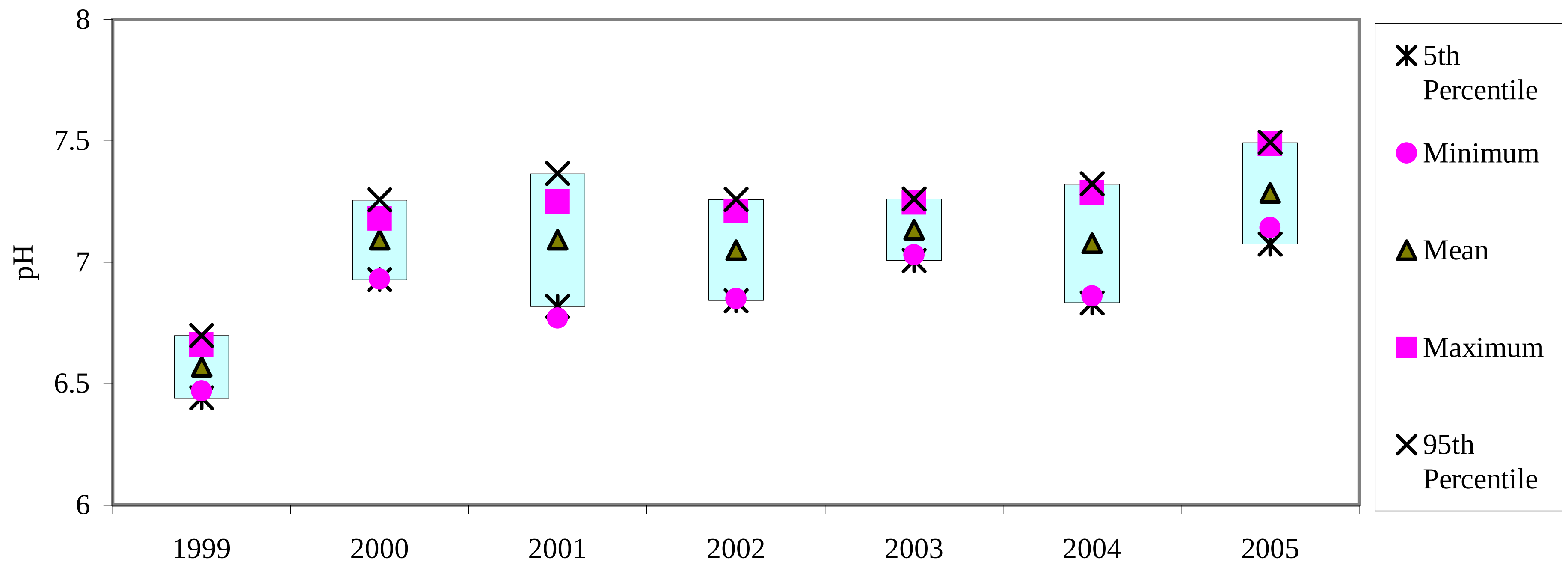
TITLE

pH OF LAKES IN THE BIRCH MOUNTAIN REGION (11 LAKES)

MEG ENERGY CORP.

PROJECT	07.1346.0009.8200		FILE No.	pH of Lakes
DESIGN	TR	03/04/08	SCALE AS SHOWN	REV. 0
CADD	TRE	04/04/08	**FIGURE: 12**	
CHECK	TR	08/04/08		
REVIEW	IGG	11/04/08		

L:\2007\1346 Oil Sands\07-1346-0009-MEG EXPANSION\8200\8220\Fig 13 pH of Lakes in the Canadian Shield Region (5 Lakes).dwg Apr 12, 2008 - 3:11pm



PROJECT

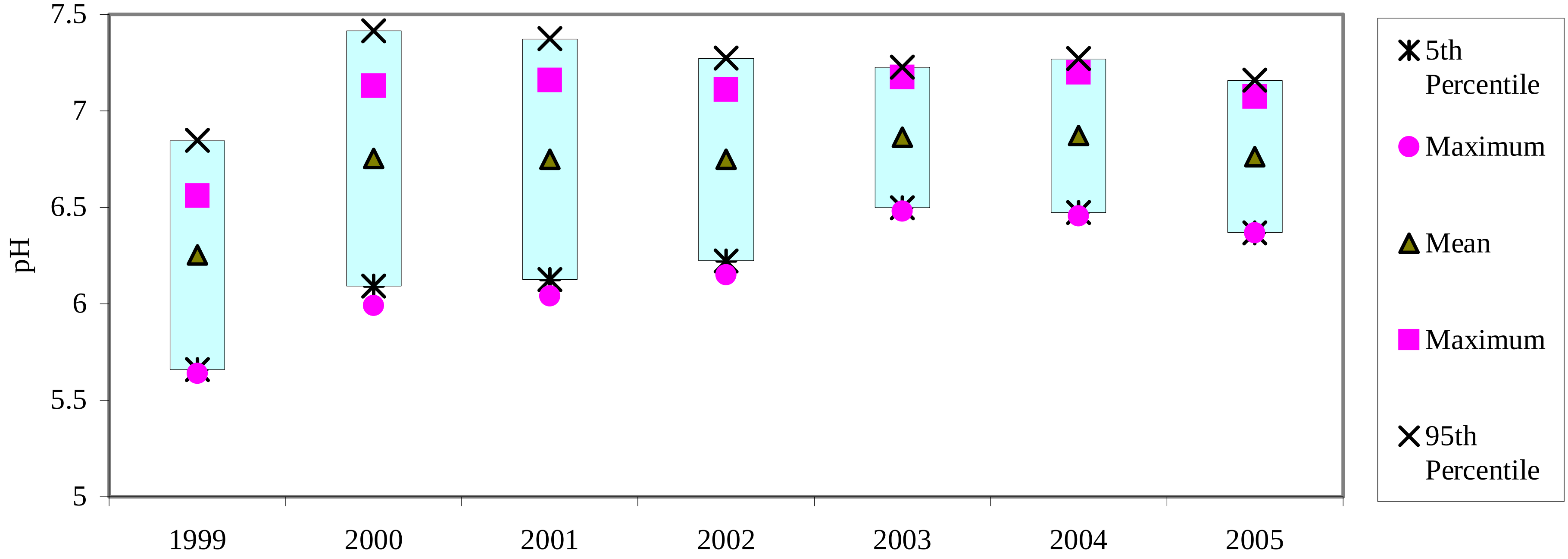
CHRISTINA LAKE REGIONAL PROJECT - PHASE 3

TITLE

pH OF LAKES IN THE CANADIAN SHIELD REGION (5 LAKES)

MEG ENERGY CORP.

PROJECT	07.1346.0009.8200		FILE No.	pH of Lakes
DESIGN	TR	03/04/08	SCALE AS SHOWN	REV. 0
CADD	TRE	04/04/08	**FIGURE: 13**	
CHECK	TR	08/04/08		
REVIEW	IGG	11/04/08		



PROJECT

CHRISTINA LAKE REGIONAL PROJECT - PHASE 3

TITLE

pH OF LAKES IN THE CARIBOU MOUNTAIN REGION (5 LAKES)

MEG ENERGY CORP.

PROJECT	07.1346.0009.8200	
DESIGN	TR	03/04/08
CADD	TRE	10/04/08
CHECK	TR	08/04/08
REVIEW	IGG	11/04/08

FILE No. pH of Lakes

SCALE AS SHOWN REV. 0

FIGURE: 14

3.2 SOILS

3.2.1 Historical Oil Sands Soil Monitoring Results

3.2.1.1 Alberta Oil Sands Environmental Research Program (1975 to 1977)

Nyborg et al. (1985) summarized a comprehensive short-term soil monitoring program in the AOSERP study area. This program included:

- nutrient cycling study that was designed to compare the chemical composition of throughfall, stemflow and litterfall of several tree species to evaluate the influence of SO_2 on foliar leaching;
- jack pine stemflow study that was designed to monitor the influence of SO_2 on the chemical composition of stemflow;
- movement of applied sulphate and sulphuric acid study in natural soils;
- rate of sulphur adsorption by bare soils study where lichen-covered soils in the laboratory at field plots were exposed to ambient SO_2; and
- effects of applied elemental sulphur, sulphuric acid and lime on soil acidity.

The sites were selected in several zones around the Suncor Energy Inc. (Suncor) base plant, as described below:

- less than 25 km from the emission source;
- 25 to 50 km from the emissions source;
- 50 to 100 km from the emissions source; and
- remote sites over 100 km from the emissions source.

The major findings of this study were as follows:

- the pH of monthly rain samples was acidic, with some samples having pH values less than five;
- the SO_4 content of rain was low and there was a gradient of decreasing SO_4 with distance from the Suncor oil sands plant;
- the sulphur content of throughfall and stemflow of aspen and jack pine was enriched compared to values in precipitation;

- both bare and lichen-covered soils absorbed SO_4 directly from the atmosphere, with a depression of pH only occurring in the top centimetre of soil;
- applied sulphate and sulphuric acid was found to be quite mobile in the soils, with the latter causing an increase in acidity with downward leaching; and
- limestone was found to be effective in neutralizing the acidity produced by sulphuric acid.

While the AOSERP study was comprehensive for the time period, the short duration of the monitoring period precluded any conclusions regarding long-term soil acidification from SO_2 emissions.

3.2.1.2 Alberta Environment Laboratory Study (1980)

Addison et al. (1981) reported the results of a laboratory study that was designed to simulate over 100 years of acid deposition on soil cores sampled from the Oil Sands Region.

This program included the following soil components:

- high concentrations of aluminum, nickel, vanadium and SO_4 were applied to soil cores collected near the Suncor oil sands plant in a jack pine and paper birch vegetation community.

The following were the major findings of this study:

- soil analysis results suggested that all elements were in their normal range, except for sulphur which was slightly elevated; and
- the authors suggested that no major conclusions could be made due to the interim nature of the results.

The study design suggests that applying acute concentrations of metals and SO_4 does not adequately simulate the chronic effects of low levels of metals and SO_4 on the soil-plant ecosystem. In addition, laboratory and greenhouse studies are not considered to be substitutes for field studies.

3.2.1.3 Alberta Environment Long-Term Soil Acidification Monitoring (1989)

Roberts and Regier (1989) summarized the results of a long-term monitoring program, which included two sites near Fort McMurray.

This program included the following components:

- a province-wide network of eight monitoring sites, with two in the Fort McMurray region, was established in 1981;
- the Fort McMurray sites were located to monitor regional emissions levels around the oil sands plants;
- parameters monitored included pH, cation exchange capacity, base saturation, electrical conductivity and exchangeable acidity; and
- the monitoring frequency was designed for every four years, for a total of 44 years.

The following were the findings from the period 1981 to 1985:

- Soil pH changed no more than 0.1 pH units for all depths.
- A significant decrease in bicarbonate (HCO_3) and increases in ammonia (NH_4) and sulphate (SO_4) were found at both Fort McMurray sites.
- There were large decreases in cation exchange capacity between 1981 and 1985 at both sites, likely due to decreases in exchangeable acidity and not due to a loss of bases. The base saturation increased as a result of the loss of exchangeable acidity.
- The lack of change in soil chemistry between the 1981 and 1985 sampling events was surprising to the investigators, since the sites were located on soils that were rated as sensitive to acidification and are located in a region with high SO_2 emissions.

The study was designed for long-term soil monitoring over a period of 44 years. The funding for this program was cancelled in the early 1990s, after one further sampling was undertaken in 1989. While the results of the 1989 monitoring have not been published, a preliminary evaluation of the results suggests that the trends are similar to those previously reported, suggesting that no changes in soil chemistry are evident after eight years of monitoring (Lutwick 1997, Pers. Comm.).

3.2.1.4 Acid Deposition Research Program (1985 to 1993)

Legge (1988) and Turchenek et al. (1993) summarized results of soil modelling and modelling validation studies relating to soil acidification in Alberta in general and to the Oil Sands Region. This program included the following components related to the Oil Sands Region:

- A joint government industry program was initiated to determine if acidifying emissions were causing adverse effects to soil, vegetation and surface water in Alberta.
- Laboratory studies were undertaken to evaluate the potential of sulphate adsorption on aluminum hydroxide compounds as a buffering process in Alberta soils.
- Computer modelling was undertaken on sensitive soils from the oil sands, using the ARC model, to evaluate how pH, base saturation and soluble aluminum will change due to various acid deposition scenarios.
- Validation of the ARC model was attempted by artificially acidifying plots near Fort McMurray, so that changes in soil parameters in the field could be correlated with model predictions. This was accomplished by applying sulphuric acid at rates from 0.3 to 4.8 keq/ha/yr.

The following were the findings of the study:

- The sulphate adsorption study concluded that Alberta soils do not adsorb sulphate, due either to a lack of amorphous minerals for adsorption or because the sites are already saturated. These results suggest that the mineral fraction of Alberta soils have limited capabilities for acting as a sink for sulphate.
- The computer modelling results suggested that pH levels in sensitive soils in the Oil Sands Region could reach levels where adverse effects could occur to forest growth in several hundred years at low acidic deposition rates and sooner at higher acidic deposition rates.
- Adding sulphuric acid to soils rated with a high sensitivity for four years, only reduced pH in the surface organic horizons in the 2.4 and 4.8 keq/ha/yr treatments (Turchenek and Abboud 1995, cited in Maynard 1996).

The Acid Deposition Research Program modelling and laboratory studies were useful in identifying and validating the mechanisms that could impact Alberta soils. Insufficient field monitoring was undertaken to validate the results and processes described.

3.2.1.5 Effects of Acidic Deposition and Metals on Soil and Vegetation (1996)

Pauls et al. (1996) summarized the results of a monitoring survey on soils and vegetation as part of ongoing monitoring by Syncrude Canada Limited (Syncrude).

This program included the following soil components:

- Samples of soil were collected at 65 sites within 100 km of the Syncrude and Suncor oil sands plants.
- The samples were analyzed for changes in soil chemistry (pH, exchangeable bases, soluble sulphate and metals) within varying distances from the emissions sources.
- White spruce wood samples were analyzed to correlate changes in soil chemistry with wood element content. Specifically, the relationship between present soil chemistry and wood concentrations of Ca, Al and metals was examined.

The following were the findings of the study:

- White spruce sample sites were located on soils classified under the Brunisolic, Gleysolic, Luvisolic, Organic and Regosolic soil orders. This suggested that white spruce can grow under diverse soil conditions.
- A trend of decreasing pH with distance from the oil sands plants was observed, which was opposite to what was expected; all 65 sites were all found to have a BC/Al ratio greater than 1, except for one site.
- Soil chemistry at the 65 sites was found to have high spatial variability within and between sites. This created challenges in relating changes in soil chemistry with oil sands emissions.
- No clear relationship was found between white spruce wood element content, specifically Al and Al/Ca ratios and soil chemistry, suggesting that no significant soil acidification effects on white spruce had occurred.

The monitoring survey was useful in evaluating if significant changes had occurred in white spruce chemistry in the Oil Sands Region. There were no measurements of white spruce growth, which did not allow for an evaluation of biomass effects from acidification. The limitations in study design preclude any detection of changes at specific sites over time, and the authors recommended the establishment of permanent plots for a long-term monitoring program.

3.2.1.6 Other Studies

Several other short-term soil monitoring studies have reported the following:

- Loman (1981) found no change in soil acidity, conductivity and buffering capacity near the Suncor oil sands plant from 1976 to 1980.
- Addison et al. (1986) reported elevated levels of sulphur, vanadium and nickel in the surface horizons of soils near the oil sands plants in 1979. It was concluded that soil chemical monitoring was not a useful short-term monitoring tool, since subtle changes in soil acidification would be difficult to detect because of the natural temporal and spatial variability of the soil.
- Addison (1982) summarized biomonitoring results near Suncor from 1976 to 1981, which included soil measurements. There was a trend of increasing total sulphur content in Litter, Fibric and Humic (LFH) horizons closest to the Suncor plant. No trend was found in soil and plant nutrient levels.

3.2.1.7 Conclusions

The short-term soil monitoring programs undertaken in the Oil Sands Region in the 1970s and 1980s did not find any significant changes in soil chemistry directly related to air emissions. It was concluded that short-term monitoring would not be adequate to detect changes due to the high temporal and spatial variability of soil chemistry in the landscape (Pauls et al. 1996). The results of these early monitoring programs lead to the realization that the effects of air emissions on soil chemistry would be long-term. Therefore, the approaches to soil monitoring in the Oil Sands Region gradually evolved into the consideration of establishing permanent plots for long-term monitoring.

3.2.2 Acid Deposition Effects on Reclaimed Soils

Since reclaimed mine soils are located close to air deposition sources, they may be potentially exposed to high levels of acid deposition. Reclaimed soils under a long-term monitoring program for the Cumulative Environmental Management Association (CEMA) Soil and Vegetation Subgroup were assessed for their soil sensitivity status (AXYS Environmental Consulting Ltd. (AXYS) and Paragon Soil and Environmental Consulting Inc. (Paragon) 2006). The results of this study follows.

Holowaychuk and Fessenden (1987) classified soil sensitivity of mineral soils based upon a synthesis of three chemical processes, including:

- sensitivity to base loss (mobilization of exchangeable cations such as Ca^2+, Mg^2+ and potassium [K+]);
- sensitivity to acidification; and
- sensitivity to solubilization of aluminum (Table 6).

Table 6 Criteria for Rating the Sensitivity of Mineral Soils to Acidic Inputs

CEC[a]	pH[b]	Sensitivity to Base Loss	Sensitivity to Acidification	Sensitivity to Aluminum Solubilization	Overall Sensitivity
<6	<4.6	high	low	high	high
	4.6 to 5.0	high	low	high	high
	5.1 to 5.5	high	medium	high	high
	5.6 to 6.0	high	high	medium	high
	6.1 to 6.5	high	high	low	high
	>6.5	low	low	low	low
6 - 15	<4.6	high	low	high	high
	4.6 to 5.0	medium	low	high	medium
	5.1 to 5.5	medium	low to medium	medium	medium
	5.6 to 6.0	medium	low to medium	low to medium	medium
	>6.0	low	low	low	low
>15	<4.6	high	low	high	high
	4.6 to 5.0	medium	low	high	medium
	5.1 to 5.5	medium	low	medium	medium
	5.6 to 6.0	low	low to medium	low to medium	low
	>6.0	low	low	low	low

(a) CEC = Cation Exchange Capacity in meq/100 g.

(b) pH in soil-water mixture.

Source: Holowaychuk and Fessenden (1987).

This system was applied to reclaimed soil monitoring data (AXYS and Paragon 2006) and presented in Table 7. The analysis showed that all nine reclaimed sites would be classified as having a low sensitivity to acidification. The pH ranges for the nine sites ranged from 5.9 to 7.5, with seven out the nine sites having pH values above 7. Also, the cation exchange capacities of the nine sites, a measure of buffering capacity, were all above 15, except for three sites (7, 95 and 97). Based on these results, the decision was made to exclude the disturbed areas for mines from the soil acidification assessment.

Table 7 Reclaimed Soil Sensitivity to Acidification

Plot ID	Cation Exchange Capacity [meq/100g]	pH	Sensitivity to Base Loss	Sensitivity to Acidification	Sensitivity to Aluminum Solubilization	Overall Sensitivity
1 TS	41.6	7.4	low	low	low	low
3 TS	15.8	7.4	low	low	low	low
5 TS	27.2	7.5	low	low	low	low
7 TS	11.6	6.2	low	low	low	low
95 TS	8.7	7.1	low	low	low	low
96 TS	27.2	7.1	low	low	low	low
97 TS	3.5	7.3	low	low	low	low
98 TS	32.8	5.9	low	low to medium	low to medium	low
99 TS	12.3	7.1	low	low	low	low

3.3 VEGETATION AND WETLANDS

The following is a summary of Terrestrial Environmental Effects Monitoring (TEEM) program of the Wood Buffalo Environmental Association (WBEA) reports over the last decade in relation to vegetation and forest health.

Vegetation stress surveys in the vicinity of Syncrude and Suncor oil sands leases using false colour infrared photography have been undertaken since the 1970s. The 1996 survey reported a 95% decrease in the area under vegetation stress between 1996 and 1990 (AGRA 1998). Of the 213 ha that showed signs of stress from air emissions, most ranked as low (200 ha). The data indicated a decreasing trend in area of vegetation under stress from air emissions since the late 1970s (AGRA 1998).

The TEEM long-term plot program was initiated in 1996 with the selection of replicated jack pine plots located close to major oil sands emission sources (high deposition zone) and plots established in a low acid deposition zone as predicted by air modelling (Conor Pacific and Landcare 1999). In 1997, the monitoring program was expanded to include replicated aspen sites also located in high and low deposition zones (Conor Pacific and Landcare 1999).

An assessment of the TEEM jack pine plots in 1998 concluded that tree growth differences between low and high deposition areas were a product of site factors and conditions and not deposition (AGRA 1999). Moisture deficits in 1999 caused impacts to the forest resulting in tree death, poor health and chlorosis. In 2000 there was continued tree death attributed to *Armillaria* root rot, but past moisture stress may be a contributing factor. In 2001 several trees noted as having poor health in the 2000 survey improved in their condition. Lastly, jack pine trees in the 2002 assessment were healthy. In all of these monitoring assessments there was no visual evidence of air pollution stress observed.

The "*Edge Effect Monitoring Program Pilot Study*" conducted in 2000 (AMEC Earth and Environmental (AMEC) 2000) found the following:

- tissue of pine bark, pine needles and lichens collected from forest edge plots demonstrated significantly higher concentration of some elements that are emitted from oil sands processing facilities or that appear to be influenced by the emissions;
- significant changes to concentrations of some elements related to the distance from emission sources were observed;
- edges are exposed to greater levels of emissions in comparison to interior forest plot stands; and
- vegetation on edges may display symptoms of impact from emissions earlier than interior plots, providing early warning of an impending problem.

3.3.1.1 Effects of Acidic Deposition and Metals on Soil and Vegetation (1996)

Pauls et al. (1996) summarized the results of a monitoring survey on soils and vegetation as part of ongoing monitoring by Syncrude.

This program included the following vegetation components:

- Samples of white spruce wood tissue, lichens, and mosses were collected at 65 sites within 100 km of the Syncrude and Suncor oil sands plants.
- White spruce wood samples were analyzed to correlate changes in soil chemistry with wood element content. Specifically, the relationship between present soil chemistry and wood concentrations of Ca, Al and metals was examined.

The following were the findings of the study:

- White spruce sample sites were located on soils classified under the Brunisolic, Gleysolic, Luvisolic, Organic and Regosolic soil orders. This suggested that white spruce can grow under diverse soil conditions.
- No clear relationship was found between white spruce wood element content, specifically Al and Al/Ca ratios, and soil chemistry, suggesting

that no significant soil acidification effects on white spruce had occurred.

The monitoring survey was useful in evaluating if significant changes had occurred in white spruce chemistry in the Oil Sands Region. There were no measurements of white spruce growth, which did not allow for an evaluation of biomass effects from acidification. The limitations in study design preclude any detection of changes at specific sites over time, and the authors recommended the establishment of permanent plots for a long-term monitoring program.

3.3.1.2 Alberta Environment Laboratory Study (1980)

Addison et al. (1981) reported the results of a laboratory study that was designed to simulate over 100 years of acid deposition on soil cores sampled from the Oil Sands Region.

This program included the following vegetation components:

- the growth response of jack pine seedlings from the compounds added was measured; and
- the response of jack pine seed germination to enriched solutions of aluminum (Al), nickel (Ni), vanadium (V) and NO_3 was reviewed.

The following were the major findings of this study:

- jack pine seedling growth was not significantly affected by the elements applied;
- jack pine seed germination was reduced at extremely high metal and SO_4 concentrations, with the response correlated with low pH; and
- the authors suggested that no major conclusions could be made due to the interim nature of the results.

The study design suggests that applying acute concentrations of metals and SO_4 does not adequately simulate the chronic effects of low levels of metals and SO_4 on a soil-plant ecosystem. In addition, laboratory and greenhouse studies are not considered to be substitutes for field studies.

3.4 RECENT ENVIRONMENTAL EFFECTS MONITORING INITIATIVES

An environmental effect monitoring program strategy and design for the establishment of permanent plots for long-term monitoring was adopted by the WBEA for implementation beginning in 1996. The program was the TEEM program. This program combines elements of ongoing biomonitoring studies by Syncrude and Canadian Natural with new studies to detect and characterize the long-term effects of oil sands plant emissions on terrestrial and aquatic ecosystems and on traditional resources.

Work initiated during 1996 included a new study involving long-term monitoring of the chemical composition of soils; forest health, regeneration and growth; and understorey vegetation composition and the abundance and diversity of lichens. The study involves long-term monitoring on permanent plots at replicated monitoring sites in two vegetation community types (jack pine and aspen) and in high and low acidic deposition zones. Monitoring protocols used by the Canadian Forest Service Acid Rain Early Warning System have been adapted for use in this program. Implementation of this study began in 1996 and 1997 with the selection of potential monitoring sites in the jack pine and aspen vegetation community types. Landscape, soil and vegetation characteristics were assessed at these sites to select a subset of ecologically analogous sites for long-term monitoring.

High deposition sites were located in areas receiving an acidic deposition of approximately 0.3 keq/ha/yr or greater as estimated by dispersion models using expected regional SO_2 emissions in the year 2001. Low deposition sites were located in areas receiving an effective acidic deposition of near or less than 0.2 keq ha/yr.

Other components of the TEEM program include:

- false colour infra-red photography to monitor vegetation stress;
- spring acid pulse monitoring in the Firebag and Steepbank rivers;
- gradient approach to monitor trace element accumulations in lichen, mosses, small mammals and soil; and
- effects on traditional resources and resource users.

Oil sands developments not anticipated when this program was designed may necessitate adaptation of the design.

The Paleolimnology Task Group of the NO_xSO_2 Working Group is performing detailed core sampling and analysis of lakes in the Oil Sands Region to provide information on how lake chemistry has changed in the last hundred years (or more) and to assess possible factors affecting the pH of the water and vegetation.

A three-year paleolimnology project has recently been completed that provides information on changes in water chemistry over time in eight lakes throughout the region. The results of the study, as reported in Hazewinkel (2006), state that "*although the rate of acid deposition associated with bitumen extraction and processing has increased substantially over the past thirty years, there is so far no indication that this has caused acidification of any of the study lakes.*"

4 AIR EMISSIONS ASSESSMENT METHODS

4.1 USE OF POTENTIAL ACID INPUT IN THE ASSESSMENT

Potential Acid Input (PAI) has historically been defined in oil sands assessments as the sum of SO_2 and NO_x deposition minus base cation deposition (keq/ha/yr) as estimated by air dispersion modelling. This calculation represents potential acid inputs entering the terrestrial ecosystem from all sources but does not take into account retention of deposited N in terrestrial ecosystems and is therefore refered to as “gross PAI”. Nitrogen absorbed in terrestrial ecosystems does not contribute to the acidification of soils or surface waters. This assessment uses a more refined approach to the estimation of potential acid input for both aquatic and terrestrial resources, by incorporating the retention of N by terrestrial ecosystems.

4.1.1 Aquatic Resources – Lakes

The air emission effects assessment for lakes is based on “lake net PAI”, which also takes into account uptake of N in terrestrial ecosystems using the same approach as used for the calculation of soil net PAI. The difference between soil net PAI and lake net PAI is in the representation of background acid inputs and base cation deposition. Background lake net PAI was calibrated based on measured sulphate and nitrate concentrations in lakes rather than from the AENV RELAD modelling (Section 4.2.2.3 of this appendix). The neutralizing effect of base cation deposition was not included in lake net PAI because base cation inputs from all sources are already accounted for in the critical load calculation (Section 4.2.2.2 of this appendix).

4.1.2 Aquatic Resources – Snowmelt pH

The predicted pH of snowmelt was used as a component of the assessment of changes in episodic acidification of streams. The historical definition of PAI, referred to as “gross PAI”, was used in the calculation of snowmelt pH, to provide a conservative estimate of pH prior to infiltration to soils. Gross PAI does not include nitrogen uptake in terrestrial ecosystems, but does include the neutralizing effect of base cation deposition.

4.1.3 Terrestrial Resources

The terrestrial air emission effects assessment is based on “soil net PAI”, which takes into account uptake of N in terrestrial ecosystems. The calculation of soil net PAI includes all SO_2 deposition, all NO_x deposition above 10 kg N/ha/yr and 25% of NO_x deposition below the first 10 kg N/ha/yr. The representation of N retention was recommended by the NO_xSO_x Working Group (NSMWG 2007) based on the conclusions of a recent report that estimated that the forest ecosystems in the Athabasca Oil Sands Region can absorb N deposition of 8 to 24 kg N/ha/yr for 100 years (Callesen and Gundersen 2005). The lower value of 8 kg N/ha/yr is near the lower limit of the range of thresholds reported for nitrogen leaching (Callesen and Gundersen 2005; Sullivan 2000). Inclusion of 25% of the deposited nitrogen under 10 kg N/ha/yr was recommended to address uncertainty.

Background SO_2, NO_x and base cation deposition were estimated based on results of the AENV Regional Lagrangian Acid Deposition Model (RELAD) model (Cheng 2001; Volume 3, Section 1 of the EIA). The incremental increase in SO_2 and NO_x above background for each assessment case was estimated using air dispersion modelling, as described in Volume 3, Section 1.2.8.3 of the EIA. Predicted SO_2 and NO_x deposition rates for each assessment case are provided in Volume 3, Sections 1.4, 1.6 and 1.7 of the EIA.

4.2 AQUATIC RESOURCES

4.2.1 Introduction

This assessment focuses on the effects of air emissions from the Project and other regional developments on water quality and aquatic biota in the air quality modelling domain (Volume 3, Section 1.2.8). Air emission scenarios are described in Volume 3, Sections 1.4, 1.6 and 1.7 of the EIA. Effects considered in this section include potential changes to the chemistry and biota of lakes, ponds and streams. For the purposes of this assessment, lakes and ponds are both referred to as “lakes”. Wetlands were combined with terrestrial systems in this assessment. The assessment of potential effects of the Project on wetlands is included in Volume 3, Section 4.4.2 of the EIA.

The sensitivity of surface waters to deposition can be evaluated based on alkalinity or Acid Neutralizing Capacity (ANC). These terms are now used interchangeably and refer to the capacity of water to neutralize strong inorganic acids (Wetzel 2001). The term “alkalinity” is typically used when neutralizing capacity is estimated using titration, whereas “ANC” is used when it is calculated. Alkalinity is often expressed in units of mg/L as $CaCO_3$, assuming that alkalinity results only from calcium carbonate and bicarbonate, which may or may not be applicable to a given lake. Therefore, the clearest expression of alkalinity is in terms of µeq/L or meq/L. For comparative purposes, alkalinity of 1 mg/L as $CaCO_3$ = 20 µeq/L, or 50 mg/L as $CaCO_3$ = 1 meq/L.

Section 4.2.2 of this appendix provides the detailed methods used to assess potential lake acidification. Section 4.2.2.1 of this appendix provides a description of the characteristics of acid-sensitive lakes, which serves as background information for understanding acid sensitivity in the Oil Sands Region. Methods for calculating critical loads are provided in Section 4.2.2.2 of this appendix. The assessment approach for lakes was based on the application of critical loads according to the Steady-State Water Chemistry (SSWC) model (Henriksen and Posch 2001). Lake-specific critical loads were compared with the corresponding lake net PAI. Adjustments were made to the critical load calculation to account for the effects of organic acids that may affect the ANC of lakes with high Dissolved Organic Carbon (DOC) content, using the method described by RAMP (2005).

Section 4.2.2.3 of this appendix provides the methods used to estimate lake net PAI under background conditions and for each assessment case. Background SO_2 and NO_X inputs were calibrated based on sulphate and nitrate concentrations measured in lakes. Incremental lake net PAI for each assessment case was based on the incremental deposition of SO_2 and NO_X predicted by air dispersion modelling (Volume 3, Section 1 of the EIA). All SO_2 deposition above background levels was included in lake net PAI, as well as all NO_x deposition above 10 kg N/ha/yr and 25% of the first 10 kg N/ha/yr. Again, the neutralizing effect of base cation deposition was not considered in the estimate of acid deposition because it is already accounted for in the critical load.

The potential for episodic stream acidification (i.e., spring acid pulses) was evaluated using a weight-of-evidence approach that included qualitative and quantitative methods taking into account the following:

- changes in SO_2 and NO_X emission rates in the region and the predicted contribution of the Project;
- changes in snowmelt pH in the region and the predicted contribution of the Project;
- the degree of stream acid sensitivity estimated from water chemistry, watershed characteristics and climate; and
- the results of an analysis of data collected by AENV during spring acid pulse monitoring in the Oil Sands Region (WRS 2002).

Details regarding how these factors affect stream sensitivity as well as the approach used to estimate the pH of snowmelt are provided in Section 4.2.3 of this appendix.

4.2.2 Lake Acidification

4.2.2.1 Characteristics of Acid-Sensitive Lakes

Acid-sensitive lakes are situated in areas where the soils have little or no capacity to reduce the acidity of the atmospheric deposition. Soil chemistry (particle size, texture, soil pH and cation exchange capacity), soil depth, drainage, vegetation cover and type, bedrock geology and topographic relief are all factors that determine the sensitivity of the drainage basin to acid deposition (Lucas and Cowell 1984; Holowaychuk and Fessenden 1987; Sullivan 2000). Surface waters that are sensitive to acidification from acid deposition usually have the following characteristics, as summarized by Sullivan (2000):

- they are dilute, with low concentrations of all major ions (i.e., specific conductance is less than 25 µS/cm);
- alkalinity/ANC are low (i.e., less than 10 mg/L as $CaCO_3$ or less than 200 µeq/L);
- base cation concentrations are low (i.e., in relatively pristine areas, the combined concentration of calcium, magnesium, potassium and sodium in sensitive waters is generally less than 50 to 100 µeq/L);
- the pH is low (i.e., less than 6.5); and
- physical characteristics are as follows:
  - elevation is moderate to high;
  - lakes are located in areas of high relief;
  - lakes are subject to severe, short-term changes in hydrology;
  - there is minimal contact between drainage waters and soils or geologic material that may contribute weathering products to solution; and
  - sensitive lakes may have small drainage basins that derive much of their hydrologic input as direct precipitation to the lake surface.

Saffran and Trew (1996) presented a scale of lake sensitivity to acidification based on alkalinity (Table 8) and developed a sensitivity map of Alberta lakes using available data for 1,156 lakes in the province.

Table 8 Acid Sensitivity Scale for Lakes Based on Alkalinity/Acid Neutralizing Capacity

Acid Sensitivity	Alkalinity/ANC	
	[mg/L as $CaCO_3$]	[µeq/L]
high	0 to 10	0 to 200
moderate	>10 to 20	>200 to 400
low	>20 to 40	>400 to 800
least	>40	>800

Source: Saffran and Trew (1996).

4.2.2.2 Use of Critical Loads

Critical loads of acidity can be used to evaluate the likelihood of lake acidification (CASA 1996; Henriksen et al. 1992; Kamari et al. 1992a, 1992b; Posch et al. 1992; Rihm 1995; RMCC 1990; WHO 1994). The critical load has been defined in general terms as “a quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge” (Nilsson and Grennfelt 1988). For evaluating the effects of acid deposition, the critical load can be thought of as an estimate of the amount of acidic deposition below which no significant harmful effects occur to a specified component of a lake’s ecosystem (e.g., a valued fish species) (Sullivan 2000).

The calculation of critical loads is based on a dose-response relationship between ANC and an aquatic organism considered important to the ecosystem. Many studies have shown that the effects of acidification on aquatic organisms are better correlated with ANC than with pH (as reviewed by Sullivan 2000) because pH measurements are sensitive to CO_2 effects (Stumm and Morgan 1981; Sullivan 2000).

Calculation of Critical Loads Without Consideration of Organic Acids

The formula used to calculate critical load from Henriksen et al. (1992) is:

$$CL = ((BC^*)_0 - (ANC)_{lim}) \times Q$$

where:

CL = critical load;

$(BC^*)_0$ = pre-industrial non-marine base cation concentration (keq/L), assumed to correspond to the current values in Alberta lakes, because they are considered unaffected by acidification at the present;

$(ANC)_{lim}$ = critical value for acid neutralizing capacity (75 µeq/L = 7.5×10^{-8} keq/L) based on the generally accepted pH effects threshold of 6, as recommended by CEMA (2004); and

Q = mean annual runoff to the lake (L/ha/yr).

While Henriksen and Posch (2001) and Henriksen et al. (2002) converted the present-day base cation flux (i.e., the $(BC^*)_0$ term in the critical load equation) to a pre-acidification flux for Nordic lakes and Ontario lakes, the procedure applied here assumes that the current conditions are representative of the pre-industrial conditions. Anthropogenic lake acidification has not been observed in Alberta, based on a review of AENV monitoring data by Schindler (1996) and data collected subsequently by the Acid Sensitive Lakes component of the Oil Sands RAMP (Golder 2000, 2001, 2002, 2003; RAMP 2004, 2005, 2006, 2007). Therefore, use of recent lake water quality data were considered appropriate for calculating critical loads, without adjusting the base cation term.

An ANC_{lim} for northern Alberta was derived by WRS (2000). The ANC_{lim} was based on a pH effects threshold, which was then converted to ANC based on a large data set for northeastern Alberta lakes. Numerous studies have shown that a pH of 6 is sufficient to maintain a healthy aquatic ecosystem and to protect fish and other aquatic organisms (RMCC 1990; Jeffries 1997; Sullivan 2000). To convert the pH effects threshold of 6 to the ANC_{lim} for northeastern Alberta, WRS (2000) developed an empirical relationship between pH and ANC, using the results of a lake survey conducted in northeastern Alberta in 1998 by Al-Pac Forest Industries and AENV. This analysis showed that for the lakes in this region, a pH of 6.0 corresponds to an ANC of about 75 μeq/L, which was adopted as the ANC_{lim} for calculating critical loads.

Calculation of Critical Loads Taking Organic Acids Into Consideration

The 2004 RAMP report (RAMP 2005) provided an alternative method for the calculation of critical loads that takes into account the effects of organic acids. The original Henriksen model was modified to account for both the buffering of weak organic anions and the lowering of ANC attributable to strong organic acids. The modified model assumed that DOC, with its associated buffering from weak organic acids (ANC_{org}) and reduction of ANC from strong organic acids (SA_{org}), was exported from the catchment basin to the lake in the same way as base cations (carbonate alkalinity). The relationships developed between ANC_{org}, DOC and pH, and between SA_{org} and DOC were substituted into the Henriksen equation:

$$CL = ((BC^*)_0 + (ANC_{org}) - (SA_{org}) - (ANC)_{lim}) \text{ x } Q$$

where:

$ANC_{org} = 0.00680 * DOC^{(0.8833*pH)}$; and

$SA_{org} = 6.05 * DOC + 21.04$.

The constants for the above two empirical expressions relating DOC and pH to weak and strong organic acids were estimated based on the population of RAMP lakes (RAMP 2005). ANC_{org} and SA_{org} were estimated for lakes included in the assessment using historical DOC and pH values. When pH or DOC were not available, the critical load was not recalculated. The modified approach to calculating critical loads has been adopted in subsequent RAMP reports (RAMP 2006, RAMP 2007) and the updated critical loads were also used for the lakes assessment (Section 4.2.7).

4.2.2.3 Lake Net Potential Acid Input Used for Comparisons With Critical Loads for Lakes

Lake net PAI was expressed as the sum of background lake net PAI and incremental lake net PAI due to oil sands project-related emissions for each assessment case. The methods describing the estimation of each component of lake net PAI follow.

Background Lake Net Potential Acid Input

In previous assessments in the region (Suncor 2005; Imperial Oil Resources Limited (Imperial) 2005; Shell Canada Energy (Shell) 2005; MEG Energy Corporation (MEG) 2005), the background PAI was based on the background acid deposition rate predicted by the AENV RELAD modelling (Cheng 2001). In this assessment, background lake net PAI was calibrated based on measured sulphate and nitrate concentrations in lakes.

Background nitrogen or sulphate inputs (I, in units of keq/ha/yr) were calculated as follows:

$$I = \frac{CxfxQ}{A}$$

where C is the concentration in the lake (mg/L), f is a conversion factor to convert from concentration reported as mg/L to keq/L, Q is the average annual outflow from the lake (L/yr) and A is the gross catchment area of the lake (ha). Background lake net PAI is the sum of the sulphate and nitrate inputs.

This approach to estimate nitrate and sulphate inputs is common to many dynamic and steady-state models (Cosby et al. 1995; Larrsen et al. 2004; Wright et al. 1998). The input rates, as calculated in the above equation, are assumed to be the leaching rate from the catchment to the lake; however, uptake and transformation within lakes and wetlands would also contribute to the difference between acid deposition and background lake net PAI.

Incremental Lake Net Potential Acid Input Due To Project-Related Emissions

Acid deposition was estimated by modelling as described in Volume 3, Section 1. Acid input to lakes above background (incremental lake net PAI) was expressed based on SO_2 and NO_x deposition above background. All SO_2 deposition above background was included. All NO_x deposition above 10 kg N/ha/yr and 25% of the first 10 kg N/ha/yr was included. Background NO_x deposition was estimated based on the assumption that lake net PAI was 25% of background deposition (i.e., that 75% of deposited nitrogen under 10 kg/ha/yr is taken up in the terrestrial ecosystem). The background NO_x deposition was added to predicted incremental deposition above background prior to calculation of N removal.

In the steady-state water chemistry model used to estimate critical loads, the base cation component of the critical load is assumed to represent the current base cation flux to the lake from all sources, including base cation deposition from the atmosphere. Therefore, adjusting the acid deposition rate by accounting for the neutralizing effect of base cation deposition, as done when using the soil net PAI or gross PAI, would result in double-counting of base cations. Considering this, inclusion of base cations in the lake net PAI calculation would result in a reduction in conservatism because the buffering capacity from base cation deposition would be overestimated.

Two additional methods were used to calculate acid inputs to determine whether the updated approach affected the results of the assessment, compared to approaches used previously in the Oil Sands Region. The first method used the soil net PAI (background acid input based on the AENV RELAD modelling and removal of N in terrestrial ecosystems). The second method used total acid inputs (background acid input based on the AENV RELAD modelling and not accounting for removal of N in terrestrial ecosystems). The results of these additional methods are provided for reference but were not used as the basis of the assessment of air emission effects on lakes.

4.2.2.4 Data Sources

Basin Characteristics and Critical Loads

Gross catchment area and net annual inflow were used to calculate lake critical loads (Section 4.2.2.2). Data sources for these variables and literature derived critical loads were as follows:

- a study of acid-sensitive lakes under the Western and Northern Canada Technical Committee (Erickson 1987; WRS 2004);

- a summary of chemistry and critical loads for 162 lakes sampled by Alberta-Pacific Forest Industries during 1998 (Syncrude 2000; WRS 2004);
- a study of small ponds in the region (WRS 2004);
- the Canadian Natural Resources Limited (Canadian Natural) Primrose East Expansion Hydrology Baseline Report (Canadian Natural 2006);
- the Canadian Natural Primrose and Wolf Lake (PAW) In-situ Oil Sands Expansion Project (Canadian Natural 2000);
- OPTI Long Lake Project EIA (OPTI 2000);
- Petro-Canada Meadow Creek Project EIA (Petro-Canada 2001);
- TrueNorth Fort Hills Oil Sands Project (TrueNorth 2001);
- Rio Alto Kirby Project EIA (Rio Alto 2002);
- Canadian Natural Horizon Oil Sands Project (Canadian Natural 2002);
- Shell Canada Limited (Shell) Jackpine Mine – Phase I Application EIA (Shell 2002);
- Husky Energy Inc. Tucker Thermal Project (Husky 2003);
- Imperial Oil Kearl Oil Sands Project – Volume 2. Baseline Report (Imperial 2005);
- Shell Muskeg River Mine Expansion EIA (Shell 2005);
- MEG Christina Lake Regional Project Phase 3 (Volume 4, Appendix 4-IV); and
- Suncor Voyageur South Project (Golder 2007).

Water Quality

Water quality data sources included those listed above as well as:

- Alberta Environment Water Data System (WDS) data for Birch Lake, Christina Lake, Gregoire Lake, Kearl Lake, McClelland Lake, Burt Lake, May Lake, Marie Lake, Leming Lake, Tucker Lake, Ethel Lake, Hilda Lake, Touchwood Lake, Lac la Biche, Wolf Lake, Field Lake, Pinehurst Lake, Cold Lake, Manatokan Lake and Dolly Lake;
- Sensitivity of Alberta Lakes to Acidifying Deposition: an Update of Sensitivity Maps with Emphasis on 109 Northern lakes (Saffran and Trew 1996);
- Imperial Oil Nabiye and Mahihkan North EIA (Imperial 2002); and

- Regional Aquatics Monitoring Program data (RAMP 2004, 2005, 2006, 2007).

Duplicate Lakes

Some lakes have been sampled in several sampling programs and it is not always clear whether samples correspond to the same lake because each sampling program used different lake identifiers. The original identifier from each study is included in the tables showing assessment results. Some of the lakes were identified as duplicates by WRS (2000) and a list of these lakes was obtained. Duplicate lakes were also identified by Saffran and Trew (1996). Additional duplicate lakes were identified based on similarity of lake co-ordinates (i.e., those within 500 m of each other) and duplication was verified using satellite imagery.

4.2.3 Episodic Stream Acidification

4.2.3.1 Evaluation of Stream Sensitivity

The primary concern regarding acidification of streams is episodic acidification during the spring snowmelt, also referred to as a spring acid pulse. Episodic acidification is a widespread natural phenomenon in surface waters, most often in response to hydrological events, such as snowmelt or rainfall (Sullivan 2000). Acid deposition from industrial sources can contribute to episodic acidification, potentially resulting in a more severe depression of pH and a longer recovery period than under natural conditions.

The sensitivity of streams to episodic acidification depends on several factors related to runoff and basin characteristics. Low order (small) streams with watersheds at high elevations, steep topography, extensive areas of exposed bedrock, deep snowpack and shallow, base-poor soils are considered to be the most sensitive to episodic acidification (Sullivan 2000).

Similar to lakes, the primary indicator of acid sensitivity in streams is the alkalinity or ANC. The generally accepted categories of acid sensitivity for streams are provided in Table 9 (Boward et al. 1999). Musselman (1996) specified spring baseflow as the basis for assessing acid sensitivity, whereas Boward et al. (1999) did not specify the flow conditions. A value of 150 µeq/L (annual average) has also been used as the cut-off point for designating streams as acid sensitive, based on the lack of responses by fish populations to acid deposition in streams with ANC more than 150 µeq/L (Brewer et al. 2000).

Table 9 Acid Sensitivity Scale for Streams Based on Alkalinity/Acid Neutralizing Capacity

Acid Sensitivity	Alkalinity/ANC [µeq/L]
acidic	<0
highly sensitive	0 to 50
sensitive	>50 to 200
not sensitive	>200

Source: Boward et al. (1999).

4.2.3.2 Changes in the pH of Snowmelt

To assess the potential contribution of changes in emissions to episodic stream acidification, change in snowmelt pH was predicted for each of the catchments of the 416 lakes assessed.

Approximately 30% of the total annual average precipitation falls as snow in the Oil Sands Region (Environment Canada 1998). The hydrogen ion concentration in snow was calculated as the gross PAI divided by the precipitation rate, and was then converted to pH (i.e., the negative logarithm of hydrogen ion concentration). Precipitation during snow pack accumulations was estimated by assuming that precipitation falls as snow for eight months of the year and that about 30% of the total annual precipitation falls as snow. Therefore, the precipitation rate in the form of snow during winter months is about 55% lower than the mean annual precipitation rate in the region. The gross PAI was used in the calculation rather than net PAI to include all deposited N and the neutralizing effect of base cation deposition, which was not otherwise accounted for in the stream assessment.

4.3 SOILS

The soil classification in the Terrestrial Air Study Area (TASA) is based on the AOSERP soil map (Turchenek and Lindsay 1982) and later updates (Abboud et al. 2002). In a recent study by the CEMA NSMWG (Golder 2004), unique critical loads were calculated for each soil series in the Oil Sands Region for three soil buffering cases using the Alberta Research Council (ARC) model (Abboud et al. 2002) (Table 10). This project also involved updating the original AOSERP soil mapping and legend (Turchenek and Lindsay 1982) to include additional bog and fen classifications and soil series.

Table 10 Series-Specific Mid Case and Fixed Case 50-Year Critical Loads

Soil Series	Series Symbol	50-Year Mid Case Critical Load [keq/ha/yr H+]	50-Year Fixed Case Critical Load [keq/ha/yr H+]
Algar	ALG	0.4	1.1
Bayard	BYD	0.7	0.7
Bitumount	BMT	0.5	1.1
Buckton	BKN	1.1	1.1
Chipewyan	CPN	1.1	1.1
Conklin	CNK	1.1	1.1
Dalkin	DKN	1.1	1.1
Dover	DOV	1.1	1.1
Firebag	FIR	0.55	1.0
Fort	FRT	0.9	1.1
Gipsy	GPY	1.1	1.1
Gregoire	GGR	0.5	0.5
Hartley	HLY	1.1	1.1
Horse River	HRR	1.1	1.1
Joslyn	JSN	1.1	1.1
Kearl	KEL	0.8	1.1
Kinosis	KNS	1.0	1.1
Legend	LGD	1.1	1.1
Livock	LVK	1.1	1.1
Mamawi	MMW	1.1	1.1
Marguerite	MAR	0.4	0.8
Mariana	MRN	0.8	1.1
McLelland	MLD	1.1	1.1
McMurray	MMY	1.1	1.1
Mikkwa	MKW	0.8	1.1
Mildred	MIL	0.4	1.0
Muskeg	MUS	0.6	1.0
Namur	NAM	1.1	1.1
Ruth Lake	RUT	1.1	1.1
Steepbank	STP	0.4	1.1
Surmont	SRT	1.1	1.1
Wabasca	WBC	1.1	1.1

The following organic soil series are included in the regional oil sands soil map:

- Conklin - moderate rich fen - Fibric Mesisol;
- Gregoire - bog - Typic Fibrisol;
- Hartley - extreme rich fen - Terric Mesisol;
- Muskeg - poor fen - Mesic Fibrisol;
- Mariana - poor fen -Terric Mesic Fibrisol;
- Wabasca - moderate rich fen - Terric Fibric Mesisol; and
- McLelland - extreme rich fen - Typic Mesisol.

Three soil buffering cases that represent differing levels of soil chemistry change allowed were used for calculating soil critical loads. These cases included:

- 75% Case: the lowest critical load determined for 75% of base saturation or base cation/aluminum ratio (mineral soils) or base cation to hydrogen ratio (organic soils).
- Mid Case: the lowest critical load determined for 50% of the difference between the starting and literature-based values for a parameter. The literature-based values were 0.1 for base saturation and 2 for base cation to aluminum ratio and base cation to hydrogen ratio.
- Fixed Critical Value Case: the lowest critical load determined for the literature-based values of 0.1 for base saturation and 2 for base cation to aluminum ratio and base cation to hydrogen ratio.

The critical load chosen to be most representative to assess environmental effects to soils in the Oil Sands Region is the 50-year fixed-case critical load (Table 10). The fixed-case critical load is defined as the base cation/aluminum or base saturation of the soil when effects to vegetation would be predicted to occur. In contrast, the 50-year mid-case critical load is the PAI load that is predicted to cause a 50% reduction in BC/Al or BC/H ratio after 50 years of exposure. This follows suggestions from the NSMWG Management Framework (CEMA 2004) that no exceedance of management objectives are expected within 30 years of present. Considering that oil sands emission have been ongoing for about 30 years, the 50-year critical load would integrate the past and future emissions.

The soil critical load exceedance values used for this impact assessment were calculated for non-disturbed areas only. Soil acidification levels above critical loads were quantitatively evaluated to meet the intent of the CEMA publication “Recommendations for the Acid Deposition Management Framework for the Oil Sands Region of North-Eastern Alberta” (CEMA 2004). This procedure was as follows:

- soil series-specific critical loads fixed case for each soil series in the TASA (Table 10) were selected for the analysis;
- the soil net PAI contours from air dispersion modelling were calculated for the Baseline, Application and Planned Development cases;
- the soil net PAI contours for the Baseline, Application and Planned Development cases were overlain on the soil maps and a Geographic Information System (GIS) was used to designate the areas in the TASA where soil critical loads were exceeded;

- as per the CEMA (2004), if a lake critical load was exceeded, the soils in the watershed of the lake were assumed to have critical loads exceeded;
- the area and percentage of soils above critical loads for each township in the TASA was outlined on a map and presented in tables;
- the net change in areas affected between the Existing and Approved (EAC) and Project Case for the TASA was calculated; and
- impact ratings were made based on the total areas affected in the TASA for both the Project Case and Planned Development Case (PDC).

4.3.1.1 Assumptions and Uncertainty

There are several assumptions used in the analysis that should be considered, including:

- the series-specific critical loads selected for the EIA were adopted from modelling and were not based on site-specific monitoring data;
- PAI values derived from air dispersion models have not been fully field verified in Alberta;
- acid deposition is recognized as a long-term chronic issue that may take many decades for changes in soil chemistry to be detected; and
- monitoring programs are currently in place in northeastern Alberta to act as an early warning system of potential changes in soil chemistry.

4.4 TERRESTRIAL VEGETATION AND WETLANDS

Air emissions from oil sands operations that may affect the health of vegetation are as follows:

- SO_2 and NO_2, which can affect vegetation directly through deposition or high concentrations;
- nitrogen deposition;
- NO_X and SO_2, which can indirectly affect vegetation through deposition on soil and water, measured as PAI; and
- ozone.

4.4.1 Sulphur Dioxide and Nitrogen Dioxide

The sensitivity of vegetation to direct SO_2 impacts is fairly well documented (Malhotra and Blauel 1980; Torn et al. 1987; Legge et al. 1988; Bruteig 1992). The importance of NO_X as an air emission that may affect vegetation and wetlands resources has only been recognized relatively recently. Air emissions, including NO_2, have been shown to affect lichens. Studies of the corticolous (tree dwelling) lichens, *Evernia mesomorpha* and *Usnea* spp. in the Oil Sands Region found that concentrations of air emissions and elements showed a trend of decreasing concentration with increasing distance from oil sands developments (Berryman et al. 2004; Conor Pacific 1997). The Conor Pacific (1997) study did not identify differences in the health of tree species within jack pine stands that occur within moderate and high depositional areas.

For analysis the procedure is:

- isopleths of SO_2 and NO_2, representing the AAAQO, are overlain with the regional vegetation map using GIS;
- developed areas are removed from the analysis, as there is assumed to be no impact to vegetation in a developed area; and
- the maximum concentrations outside of developed areas and the percent change in areal extent of the exceedance are reported for each assessment case.

Residual effects are based on change, calculated by subtracting the case percent area from the EAC area and dividing the result by the EAC total vegetated area, then multiplying by 100.

4.4.2 Sulphur Dioxide Sensitivity

To demonstrate some of the variability of SO_2 effects to vegetation, annual SO_2 emissions were modelled as follows:

- vegetation mapped as having a high sensitivity may be affected at critical loads greater than 10 $\mu g/m^3/yr$;
- vegetation mapped as having moderate and high sensitivities may be affected at critical loads greater than 20 $\mu g/m^3/yr$; and
- all vegetation (low, moderate and high sensitivities) may be affected at critical loads greater than 30 $\mu g/m^3/yr$ (annual SO_2 AAAQO).

This approach is similar to the model that the CASA developed for soil critical load levels of PAI (CASA 1999). The vegetated areas within these deposition rates are reported in hectares and the percent change is calculated by subtracting the PDC percent area from the EAC percent area and dividing the result by the EAC total vegetated area, then multiplying by 100.

4.4.3 Nitrogen Deposition

Critical loads of 0.25 keq N/ha/yr are measured as the point where vegetation has the potential to respond to anthropogenic sources of nitrogen and 2.0 keq N/ha/yr gives a conservative estimate of the point where there is the potential of a negative effect on net primary production. The poor fen/bog regional vegetation class has the highest potential for negative effect due to nitrogen deposition in the TASA. Therefore, the area of the poor fen/bog regional vegetation class within the isopleths was calculated using GIS. For each assessment case, the poor fen/bog regional vegetation class areas and percentage area affected are reported.

4.4.4 Acidification

Acidification is indicated using soil net PAI, which takes into account deposition of SO_2 and NO_X emissions, as well as other relevant factors (Section 4.1). The methods for the assessment of effects of soil net PAI on soils using the critical load approach is outlined above. To measure indirect effects to vegetation, soil polygons with critical load exceedances were overlain on the regional vegetation map to delineate vegetation classes where acid deposition was above critical loads in the TASA. The vegetated area potentially affected by soil net PAI will differ from the soils area as areas without vegetation, such as disturbances, are removed from the reported area. The percent change is calculated by subtracting the EAC percent area from the EAC percent area and dividing the result by the EAC total vegetated area, then multiplying by 100.

4.4.5 Ozone

Ozone exerts a phytotoxic effect on vegetation only if a sufficient amount reaches sensitive sites in the leaf. At present, an appropriate conceptual model for predicting changes in ground-level ozone in the region is not available.

4.5 WILDLIFE AND WILDLIFE HABITAT

Emissions of SO_2 and NO_X may result in direct effects to vegetated areas, and indirect effects via PAI. Assessment of air emission effects on wildlife and wildlife habitat are restricted to woodland caribou habitat with high lichen food value, (lichens being especially sensitive to acidification), including:

- coniferous – jack pine;
- mixedwood – jack pine-aspen dominant;
- coniferous – black spruce-white spruce (jack pine) dominant; and
- poor wooded fen/wooded bog.

The amount of sensitive vegetation (i.e., ecosite phases containing lichens) that may be affected are determined and mapped, for:

- SO_2 critical loads greater and 10 $\mu g/m^3/yr$ (WHO guideline);
- NO_2 critical loads greater then the annual AAAQO (60 $\mu g/m^3/yr$); and
- woodland caribou habitat on soils potentially affected by PAI.

The amount of sensitive wildlife habitat above each air emission species critical load is reported, and the percent change assessed. Percent change is calculated by subtracting the PDC percent area from the EAC percent area and dividing the result by the EAC total vegetated area, then multiplying by 100.

5 DETAILED RESULTS FOR AQUATIC RESOURCES

5.1 ACID SENSITIVITY OF SURFACE WATERS IN THE REGION

5.1.1 Lakes

Most lakes and ponds in Alberta are well buffered against acidification because they are situated in areas with carbonate-rich soils and bedrock. Standing waters in northeastern Alberta generally do not display the characteristics of acid-sensitive waters (i.e., dilute, poorly buffered, low pH, low concentrations of base cations and organic acids, high elevation and relief, hydrology subject to flash flood conditions and small basins). However, acid-sensitive lakes have been identified in upland regions of northeastern Alberta, including the Muskeg, Caribou, Birch and Stony mountains (Saffran and Trew 1996; WRS 2004).

To provide an indication of water chemistry and acid sensitivity of lakes in the Air Quality Regional Study Area (RSA), available data were summarized for each of the 416 Alberta lakes selected for the assessment (Table 11). Using the classification system of Saffran and Trew (1996), the alkalinity data indicate that 32 lakes are highly sensitive, 33 lakes are moderately sensitive, 75 lakes have low sensitivity and 274 lakes are least sensitive. Two of the lakes (Sandy and Cluff lakes) could not be classified because alkalinity data were not available; however, based on conductivity, which is usually highly correlated with alkalinity, these lakes would fall in the least sensitive category.

Table 11 Summary of Water Chemistry Data Related to Acid Sensitivity of the 416 Lakes Included in the Assessment

Lake Identifier(a)	Lake Name / Original Identifier	Easting [UTM](b)	Northing [UTM](b)	Distance [km](c)	Direction(c)	Conductivity [µS/cm]	TDS [mg/L]	DOC [mg/L]	Colour [TCU]	pH	Sulphate [mg/L]	Nitrate + Nitrite [mg/L]	Calcium [mg/L]	Magnesium [mg/L]	Sodium [mg/L]	Potassium [mg/L]	Alkalinity [mg/L as $CaCO_3$]	Acid Sensitivity(d)
618	Unnamed WB 9-04(e)	515711	6168936	2	W	123	143	8	77	7.9	1.5	-	17	6.0	2.7	0.5	61	least
617	Unnamed WB 7-04(e)	515450	6170023	3	WNW	69	90	30	53	7.6	1.3	0.050	8	4.3	1.7	0.5	32	low
616	Unnamed WB 8-04(e)	514431	6168793	3	W	134	124	9	48	8.0	1.1	-	18	6.3	3.0	0.4	68	least
620	Unnamed WB 11-04(e)	522016	6168496	4	E	102	92	9	40	8.0	1.1	0.050	14	5.0	1.2	0.5	51	least
609	Unnamed WB 2-07(e)	520557	6172578	5	NE	152	137	25	24	8.1	2.1	0.050	18	6.7	3.7	1.7	75	least
614	Unnamed WB 15-04(e)	513212	6167678	5	WSW	148	143	11	50	8.0	1.1	-	20	7.0	2.5	0.2	76	least
231	95(f), Unnamed WB 6-04(e)	516751	6175506	7	N	59	67	20	66	7.6	1.0	0.038	8	2.5	1.8	0.7	28	low
615	Unnamed WB 5-04(e)	513525	6175472	8	NNW	53	71	9	78	7.6	0.8	-	8	2.3	0.8	0.5	25	low
610	Unnamed WB 3-07(e)	509795	6169983	8	W	69	78	19	45	7.8	0.7	0.050	9	2.7	2.0	0.8	33	low
621	Unnamed WB 13-04(e)	523415	6162401	9	SE	180	149	11	66	8.8	1.4	-	25	8.3	3.3	0.8	98	least
2	Christina	510499	6163433	9	SW	197	125	14	36	7.9	5.4	0.031	25	7.5	6.3	1.0	104	least
612	Unnamed WB 2-04(e)	508500	6170350	9	W	84	61	15	32	7.8	0.8	-	11	3.7	2.3	0.8	43	least
613	Unnamed WB 16-04(e)	509779	6174077	10	WNW	68	111	10	190	7.5	1.1	-	11	3.0	0.8	0.6	31	low
611	Unnamed WB 4-07(e)	527280	6170976	10	ENE	81	93	18	39	7.8	0.8	0.067	11	3.3	1.4	0.6	40	least
147	94(f), 94(354)(g),Unnamed WB 1-07(e)	515689	6179208	10	NNW	48	75	22	31	7.3	1.0	0.023	6	1.7	1.3	1.1	19	moderate
232	97(f), Unnamed WB 12-04(e)	528841	6167222	11	E	85	65	16	44	7.8	0.7	0.038	12	3.9	1.4	0.4	43	least
233	98(f)	502625	6165269	16	WSW	105	-	21	86	7.8	0.5	0.001	14	4.5	3.5	0.8	50	least
241	108(f)	510533	6149522	21	SSW	198	-	11	29	8.2	0.5	<0.001	28	8.5	3.3	0.7	101	least
240	Kirby	514750	6146752	22	S	228	-	7	7	8.6	0.2	<0.001	32	10.1	3.6	1.1	123	least
237	Winefred, WB-WL(e)	531585	6150547	23	SE	190	125	10	11	8.4	1.4	0.040	27	7.0	3.5	0.9	104	least
230	93(f)	533411	6186731	24	NE	112	-	18	22	7.9	0.6	0.001	15	5.9	2.1	0.5	58	least
227	Bohn	520832	6196859	28	N	193	-	22	32	8.7	1.4	<0.001	26	7.6	8.4	1.4	101	least
235	101(f)	548176	6173881	31	E	142	-	19	19	8.3	-	<0.001	20	7.5	1.4	0.4	73	least
234	100(f)	547077	6178511	31	ENE	152	-	26	69	8.1	0.2	0.001	22	7.3	5.0	0.7	82	least
229	Cowper	534391	6195087	31	NNE	143	-	17	50	9.1	0.9	<0.001	19	5.9	6.1	0.9	74	least
228	90(f)	530201	6197838	31	NNE	157	-	25	96	8.0	1.8	<0.001	21	5.5	10.2	1.6	81	least
238	104(f)	544256	6146950	34	SE	144	-	20	20	9.0	0.3	0.001	21	6.4	2.8	1.1	77	least
132	Grist	533788	6137575	35	SSE	222	119	7	10	8.5	2.0	0.013	30	8.5	4.0	0.9	117	least
239	106(f)	525364	6133813	36	SSE	208	-	10	7	8.3	0.2	0.001	30	8.8	2.0	1.8	108	least
139	91(f), 7(h)	538503	6201610	39	NNE	154	87	16	48	9.2	1.6	<0.001	18	5.9	7.0	0.9	79	least
186	40(f)	521815	6208917	40	N	226	-	27	68	8.1	3.3	0.002	24	7.7	15.7	1.5	104	least
244	113(f)	492606	6137452	40	SW	128	-	14	39	8.0	0.2	<0.001	17	6.4	1.6	0.5	64	least
46	UNL4(i)	498367	6133579	40	SSW	178	121	19	18	7.9	1.3	0.075	22	8.5	2.0	0.5	89	least
44	UNL1(i)	491437	6137987	41	SW	142	82	14	18	8.0	2.1	0.083	18	6.4	2.3	0.6	70	least
236	102(f)	558657	6173086	41	E	97	-	10	25	7.9	0.5	<0.001	13	4.4	1.3	0.3	49	least
45	UNL3(i)	497711	6132160	42	SSW	80	55	18	40	7.3	0.9	0.075	10	3.7	1.0	0.4	38	low
50	UNL13(i)	489844	6137549	42	SW	35	17	24	150	6.5	2.1	<0.001	4	1.5	<0.1	0.4	13	moderate
49	UNL12(i)	493107	6134651	42	SW	96	45	15	35	7.4	1.0	0.100	11	4.3	0.5	0.4	46	least
48	UNL7(i)	491151	6134421	44	SW	94	55	24	32	7.4	1.3	0.075	11	4.4	1.3	0.6	43	least
47	UNL5(i)	493933	6132222	44	SSW	106	80	15	30	7.7	0.8	0.075	13	4.9	1.0	0.6	52	least
43	Ipiatik	496692	6127900	46	SSW	136	67	14	30	7.5	1.5	0.100	17	5.4	1.5	0.4	67	least
42	Wiau	479375	6142060	47	SW	164	106	16	24	8.2	1.2	0.063	23	7.4	2.8	0.7	88	least
243	111(f)	475751	6144012	49	WSW	68	-	19	291	7.7	0.4	<0.001	14	2.7	2.4	0.4	52	least
222	81(f)	471892	6199682	55	NW	68	-	15	41	7.6	0.2	0.002	10	2.7	1.5	0.6	31	low
167	Wappau	463161	6151511	57	WSW	185	-	10	65	9.1	0.2	<0.001	28	7.4	3.5	1.2	100	least
242	110(f)	464179	6147797	58	WSW	87	-	10	18	8.3	0.3	0.001	11	4.0	1.3	0.7	42	least
245	114(f)	468315	6136636	59	WSW	66	-	17	33	7.6	0.2	<0.001	8	3.7	1.6	0.7	30	low
180	33(f)	491196	6222316	60	NNW	24	-	18	93	6.6	0.6	0.001	3	1.3	0.9	0.3	7	high
184	Watchusk	543469	6224854	61	NNE	184	-	20	58	8.6	0.9	<0.001	25	6.5	7.5	1.1	90	least
130	32(f), 2(h)	493516	6226026	62	NNW	110	46	14	79	7.7	1.4	0.017	15	3.4	1.6	0.5	55	least
136	34(f), 1(h)	474056	6213581	63	NW	101	76	24	56	7.5	1.4	0.013	14	3.6	2.1	0.6	51	least
248	Clyde	470369	6128275	63	SW	159	-	16	48	8.1	0.3	<0.001	22	6.8	2.5	1.0	79	least
247	117(f)	467222	6132003	63	SW	120	-	22	57	7.8	0.5	0.001	13	7.4	1.9	1.3	57	least
221	80(f)	458295	6193292	64	WNW	47	-	19	38	7.3	0.2	<0.001	6	2.1	1.2	0.6	20	low
145	28(f), 28(290)(g)	487068	6225576	64	NNW	18	56	20	175	5.9	0.7	0.007	2	0.8	0.6	0.4	4	high
178	30(f)	487070	6226500	65	NNW	11	-	12	116	5.2	0.6	0.002	1	0.3	0.3	0.3	2	high
181	35(f)	540312	6230388	65	NNE	213	-	21	66	7.9	0.7	0.042	29	7.2	8.5	1.3	102	least
250	120(f)	475613	6118973	65	SW	135	-	17	24	8.7	0.2	0.001	17	6.8	2.1	0.5	66	least
185	39(f)	554875	6223126	66	NE	139	-	20	63	7.9	0.6	0.001	17	5.8	5.9	0.5	69	least
138	Goodwin	457796	6141365	66	WSW	100	52	9	16	7.7	1.4	0.013	12	4.3	0.8	0.9	50	least
249	Behan	465073	6127390	67	SW	118	-	15	30	8.2	0.2	<0.001	15	5.8	1.9	1.1	58	least
176	20(f)	525809	6235841	67	N	204	-	24	73	7.9	0.8	0.002	22	6.4	14.7	0.5	96	least
143	25(f), 25(287)(g)	487594	6229281	67	NNW	13	54	16	161	5.2	1.6	0.002	1	0.3	0.6	0.4	2	high

Table 11 Summary of Water Chemistry Data Related to Acid Sensitivity of the 416 Lakes Included in the Assessment (continued)

Lake Identifier[a]	Lake Name / Original Identifier	Easting [UTM][b]	Northing [UTM][b]	Distance [km][c]	Direction[c]	Conductivity [µS/cm]	TDS [mg/L]	DOC [mg/L]	Colour [TCU]	pH	Sulphate [mg/L]	Nitrate + Nitrite [mg/L]	Calcium [mg/L]	Magnesium [mg/L]	Sodium [mg/L]	Potassium [mg/L]	Alkalinity [mg/L as $CaCO_3$]	Acid Sensitivity[d]
175	Georges	513419	6236708	68	N	316	-	12	31	8.4	6.8	0.002	42	11.5	9.6	1.6	155	least
117	26[f], A26[g]	489502	6230877	68	NNW	14	49	11	107	5.6	1.4	0.032	2	0.5	0.6	0.5	3	high
122	86[f], A86[g]	448014	6170896	70	W	25	43	14	48	6.6	1.5	0.009	2	0.9	0.8	1.6	7	high
183	37[f]	554289	6228684	70	NNE	254	-	13	19	8.5	0.6	<0.001	31	10.9	9.6	2.8	134	least
177	22[f]	489154	6232994	70	NNW	26	-	7	61	6.9	1.3	0.004	3	1.0	0.4	0.4	11	moderate
179	31[f]	480350	6228385	70	NNW	15	-	14	221	5.6	1.4	0.279	1	0.3	0.3	0.3	3	high
116	24[f], A24[g]	484387	6230872	70	NNW	34	44	18	241	4.7	1.0	<0.001	1	0.3	0.7	0.4	1	high
218	77[f]	452595	6196133	71	WNW	68	-	23	291	7.1	0.5	0.014	11	2.7	1.6	0.5	31	low
146	82[f], 82(342)[g]	448271	6183205	71	WNW	32	107	24	62	6.8	0.6	0.011	3	1.4	1.5	1.1	11	moderate
131	Base	446510	6167454	71	W	129	69	11	62	7.6	2.2	0.014	17	4.9	1.9	0.8	62	least
225	85[f]	446589	6173942	71	W	32	-	11	56	7.2	0.5	<0.001	4	1.3	0.7	1.2	14	moderate
144	27[f], 27(289)[g]	477248	6228400	72	NW	16	32	12	42	6.5	0.8	0.001	2	0.6	0.6	0.4	5	high
220	79[f]	448879	6190611	72	WNW	68	-	16	77	7.5	0.4	<0.001	10	2.4	1.7	0.6	32	low
246	116[f]	452463	6135855	73	WSW	70	-	11	41	7.7	1.1	0.001	8	3.5	0.9	1.5	32	low
38	L8[i]	490427	6237963	74	NNW	64	103	23	217	6.8	2.3	-	10	2.5	<0.1	0.6	28	low
115	21[f], A21[g]	483819	6235130	74	NNW	15	54	17	280	5.0	3.4	0.013	2	0.4	0.8	0.4	2	high
224	84[f]	443436	6173058	75	W	33	-	11	60	7.1	0.6	0.002	4	1.3	0.8	0.9	13	moderate
251	Big Chief	458671	6121881	76	SW	114	-	18	57	7.9	0.9	<0.001	15	4.8	1.7	2.4	54	least
36	UNL3[i]	509942	6244399	76	N	207	172	35	50	7.8	4.7	0.077	25	6.8	11.0	2.3	104	least
174	17[f]	487107	6238565	76	NNW	61	-	12	142	7.4	1.3	0.009	9	2.3	1.3	0.5	28	low
118	29[f], A29[g]	466180	6224950	76	NW	13	36	13	70	5.8	0.8	0.002	1	0.5	0.9	0.3	3	high
37	Surmont	489222	6240033	77	NNW	66	73	16	108	7.0	2.7	0.167	10	2.5	0.3	0.6	30	low
259	Logan	476591	6104122	77	SSW	267	-	16	48	9.2	4.7	0.001	33	12.0	14.1	1.7	147	least
219	78[f]	444220	6193451	78	WNW	86	-	13	140	7.3	0.6	0.047	13	2.7	1.1	0.3	41	least
182	Formby	559900	6234325	78	NNE	206	-	13	26	8.1	0.3	0.004	27	6.8	8.4	0.7	97	least
258	128[f]	470756	6106015	79	SW	315	-	21	56	8.5	3.0	0.001	39	17.0	5.9	2.8	162	least
27	Pushup	503226	6248721	81	N	84	79	20	26	7.8	1.1	0.069	10	2.4	1.9	2.4	39	low
223	83[f]	438372	6185182	81	WNW	95	-	10	41	7.9	0.5	<0.001	16	2.5	0.8	0.7	46	least
110	Birch [f]	536018	6248894	82	NNE	271	130	26	17	8.8	2.1	0.013	17	11.3	25.5	1.8	143	least
34	UNL1[i]	502641	6249587	82	N	29	65	21	75	6.1	2.1	0.102	3	0.8	0.1	1.3	9	high
1	Birch [j]	504672	6250565	83	N	138	118	24	97	7.7	15.3	0.081	14	10.5	7.8	2.4	96	least
39	L10[i]	480727	6243329	83	NNW	41	83	10	33	5.8	5.8	0.133	2	0.7	<0.1	0.3	8	high
31	Rat	507487	6251545	83	N	207	141	18	31	7.8	4.5	0.077	26	7.8	6.9	1.3	104	least
40	L11[i]	481229	6244129	84	NNW	26	73	17	167	6.0	2.0	-	3	1.0	<0.1	0.3	8	high
26	Long [f]	502017	6251357	84	N	80	100	23	67	7.2	4.5	0.101	9	2.6	3.6	1.1	34	low
28	Sucker	508895	6252653	84	N	223	164	19	31	7.8	4.4	0.101	26	7.8	10.4	1.6	112	least
30	Poison	505212	6252653	85	N	180	141	25	31	7.8	2.2	0.102	23	6.2	8.1	1.2	91	least
204	63[f]	437499	6197260	85	WNW	70	-	13	80	7.5	0.4	0.001	10	2.3	2.0	0.5	29	low
41	Maqua	482249	6246921	86	NNW	59	72	12	84	6.9	1.8	-	8	2.3	0.2	0.5	27	low
257	Heart	468042	6098611	86	SW	304	-	15	31	8.9	3.4	0.001	32	13.9	16.9	2.4	157	least
29	Frog	504488	6254133	86	N	184	158	29	75	7.7	3.2	<0.001	24	7.1	8.6	1.1	91	least
173	Garson	561829	6243625	87	NNE	191	-	19	20	8.1	0.7	0.010	23	6.5	7.6	0.9	87	least
226	88[f]	438648	6204657	87	WNW	134	-	11	23	8.0	0.5	<0.001	16	4.7	4.1	0.7	50	least
202	Mariana	435473	6200997	88	WNW	150	-	11	54	7.2	3.2	<0.001	9	2.6	15.4	1.2	19	moderate
171	Gipsy	546271	6252711	88	NNE	271	-	5	4	8.5	0.4	<0.001	27	13.3	11.9	3.1	145	least
35	PF12[k], UNL2[i]	500505	6255692	88	NNW	37	74	26	118	6.2	3.2	0.101	9	<0.1	2.1	1.0	10	moderate
207	66[f]	429371	6177905	89	W	172	-	11	36	8.1	1.3	0.003	28	5.6	1.1	0.9	85	least
33	Kiskatinaw	499571	6266398	89	NNW	191	143	24	52	7.8	3.1	0.102	24	7.4	6.6	0.8	97	least
68	LK8[i]	541457	6082627	90	SSE	96	125	23	80	7.8	0.9	-	13	4.9	1.5	0.4	49	least
515	Unnamed 5[i]	522785	6041366	90	S	822	426	48	-	7.7	13.0	0.015	97	52.1	48.1	2.6	429	least
598	UN-5[i]	526700	6079500	90	S	63	27	28	-	7.2	0.1	0.003	7	2.3	<0.1	<0.1	28	low
256	Piche	461651	6098662	90	SW	316	-	12	27	8.7	3.6	<0.001	36	14.7	16.5	2.7	160	least
25	Canoe	498871	6257215	90	NNW	90	100	20	61	7.1	2.2	<0.001	10	3.2	4.3	0.9	40	least
203	62[f]	432308	6198262	90	WNW	73	-	15	126	6.9	2.1	0.002	7	2.1	4.7	0.6	14	moderate
597	UN-2[i]	522600	6078500	91	S	270	146	21	-	7.9	0.1	0.003	29	8.7	10.2	1.0	162	least
253	123[f]	444801	6114608	91	SW	285	-	8	12	8.7	1.8	<0.001	30	15.2	7.7	4.8	148	least
170	Nora	526686	6259956	91	N	157	-	21	31	9.1	0.2	0.002	17	9.2	3.3	1.1	79	least
205	Crow	426862	6184436	92	W	201	-	12	60	8.8	3.2	0.004	30	7.1	3.7	1.0	98	least
463	PF9[k]	488075	6256727	93	NNW	99	-	26	100	7.1	12.3	0.100	12	4.3	3.0	0.5	32	low
206	65[f]	425742	6179813	93	W	213	-	14	75	8.5	3.3	0.004	30	7.1	5.1	1.0	97	least
254	124[f]	446862	6109018	93	SW	200	-	16	64	9.5	0.5	<0.001	26	8.0	7.9	2.1	106	least
67	LK7[i]	538930	6078203	93	SSE	180	137	16	47	8.1	1.2	0.100	26	8.1	2.0	0.6	98	least
172	Baker	554471	6254656	93	NNE	253	-	17	20	8.7	0.2	<0.001	30	13.4	6.2	2.5	133	least

Table 11 Summary of Water Chemistry Data Related to Acid Sensitivity of the 416 Lakes Included in the Assessment (continued)

Lake Identifier[a]	Lake Name / Original Identifier	Easting [UTM][b]	Northing [UTM][b]	Distance [km][c]	Direction[c]	Conductivity [µS/cm]	TDS [mg/L]	DOC [mg/L]	Colour [TCU]	pH	Sulphate [mg/L]	Nitrate + Nitrite [mg/L]	Calcium [mg/L]	Magnesium [mg/L]	Sodium [mg/L]	Potassium [mg/L]	Alkalinity [mg/L as $CaCO_3$]	Acid Sensitivity[d]
453	PF11[k]	495869	6259633	93	NNW	43	-	32	150	6.1	2.5	0.100	5	2.0	<0.1	0.7	10	moderate
3	Gregoire	489729	6258036	93	NNW	127	77	13	25	7.4	8.5	0.041	17	4.6	3.0	0.9	55	least
252	122[f]	458438	6096843	93	SW	101	-	12	29	7.9	0.8	0.001	12	4.2	1.4	3.1	47	least
109	Gordon	530780	6261842	94	N	257	-	21	19	8.4	2.2	0.001	24	10.0	21.1	1.8	141	least
452	PF10[k]	493296	6259805	94	NNW	65	-	22	90	6.9	5.6	0.200	9	2.6	<0.1	1.3	22	low
599	UN-6[i]	529300	6074800	95	S	86	46	26	-	6.8	0.1	0.073	8	3.4	0.7	8.1	41	least
66	LK6[i]	544835	6076985	96	SSE	182	140	23	60	8.1	1.4	0.100	26	8.0	3.3	0.5	98	least
461	PF7[k]	479616	6256890	96	NNW	190	-	25	150	7.5	9.4	0.100	21	9.5	8.0	0.5	83	least
169	Shortt	548241	6260147	96	NNE	251	-	16	26	7.9	0.4	0.002	33	9.9	7.7	1.8	133	least
65	LK5[i]	543092	6075676	97	SSE	105	100	18	52	7.8	1.5	<0.001	14	4.9	2.0	0.6	52	least
32	Caribou Horn	501467	6264562	97	N	183	139	19	53	7.7	6.7	0.102	23	7.6	5.6	0.8	87	least
64	LK4[i]	540067	6073823	98	SSE	127	120	24	73	7.9	1.0	0.100	18	6.3	2.0	0.5	65	least
60	Burnt	536930	6072588	98	S	200	142	17	43	8.1	5.3	0.133	28	40.5	3.3	0.7	108	least
255	125[f]	443614	6104417	98	SW	289	-	23	73	8.5	3.0	<0.001	35	11.3	13.3	3.0	143	least
63	LK3[i]	539930	6072774	99	SSE	124	113	24	55	7.9	1.0	0.100	16	6.4	2.3	0.7	61	least
455	PF13[k]	498560	6265951	99	N	200	-	17	55	7.7	3.9	0.100	25	8.1	5.0	0.4	99	least
62	LK2[i]	539546	6071719	100	SSE	105	110	30	53	7.8	1.0	-	13	6.1	2.0	0.7	53	least
198	56[f]	432715	6224227	101	WNW	64	-	33	273	7.1	1.1	<0.001	6	1.4	8.0	0.3	23	low
61	LK1[i]	540333	6069577	102	SSE	207	153	25	30	8.2	1.8	0.100	30	10.1	4.0	1.3	117	least
536	Touchwood	474032	6075393	103	SSW	266	143	11	9	8.3	3.7	-	31	12.2	7.9	2.6	141	least
208	67[f]	414088	6172614	104	W	73	-	19	140	7.3	3.6	0.003	11	2.7	1.4	0.7	29	low
168	8[f]	559470	6264932	105	NNE	236	-	18	10	8.9	0.1	0.001	19	17.5	5.5	1.6	123	least
516	Sinclair [f]	522000	6064200	105	S	430	248	15	-	8.3	7.9	<0.001	36	24.2	29.6	2.9	243	least
199	57[f]	420621	6214236	107	WNW	54	-	27	170	7.0	3.5	0.001	7	1.4	3.9	0.2	17	moderate
69	May	539000	6063000	108	SSE	254	144	7	-	8.1	3.6	0.045	32	10.9	5.9	1.2	140	least
201	60[f]	413544	6197673	108	WNW	78	-	27	291	7.5	1.4	0.001	12	2.7	3.7	1.1	34	low
538	Wolf	503222	6061410	109	S	297	182	13	-	8.0	2.8	0.001	29	15.9	11.4	2.1	158	least
462	PF8[k]	471630	6268385	110	NNW	197	-	29	125	7.4	19.1	<0.001	14	5.2	20.0	3.0	67	least
517	Bourque	529300	6059500	110	S	334	176	7	-	8.2	3.1	0.056	33	18.7	11.1	2.5	186	least
142	6[f], 6(271)[g]	549064	6277789	113	NNE	140	111	30	26	9.0	0.3	0.023	17	5.7	5.8	0.9	70	least
209	Agnes [f]	404923	6184861	114	W	33	-	28	317	6.5	1.2	0.001	6	1.2	0.8	0.8	9	high
196	54[f]	423111	6237380	117	NW	60	-	28	327	7.2	2.8	0.001	6	1.5	7.7	0.2	21	low
530	La Loche	592417	6259032	117	NE	229	190	9	-	8.1	-	-	26	9.3	7.8	1.0	119	least
518	Marguerite	516000	6052000	117	S	951	660	95	-	8.8	0.7	<0.001	17	124.0	55.2	45.9	679	least
519	Marie	545000	6054000	118	SSE	258	156	8	-	8.1	2.8	0.100	26	13.1	5.8	2.2	141	least
459	PF5[k]	451429	6268553	120	NNW	212	-	11	13	7.9	2.8	0.100	34	6.7	1.0	0.8	111	least
520	Leming	532000	6050000	120	S	194	168	35	-	8.2	2.4	0.200	19	13.8	8.6	5.5	118	least
460	PF6[k]	450033	6268135	120	NW	179	-	24	45	7.7	2.8	0.100	29	5.2	<0.1	0.4	89	least
195	53[f]	422698	6242954	121	NW	58	-	26	335	7.2	1.5	0.001	5	1.3	7.6	0.8	22	low
540	Pinehurst	467751	6057818	122	SSW	279	152	13	-	8.5	5.0	-	32	12.9	8.4	3.8	148	least
194	Algar	420102	6242078	122	NW	69	-	18	111	7.5	6.2	<0.001	5	1.3	7.8	0.6	22	low
537	La Biche	433387	6079917	123	SW	268	138	-	-	8.6	0.1	-	29	9.0	11.0	2.3	133	least
141	4[f], 4(270)[g]	506113	6291421	123	N	151	138	39	34	8.1	0.3	0.003	21	7.4	2.0	0.3	75	least
197	55[f]	413272	6235709	124	WNW	64	-	30	291	7.1	3.4	0.001	5	1.2	9.6	0.3	21	low
600	Dolly	549700	6048200	125	SSE	441	239	40	-	8.5	5.0	0.550	14	32.0	22.0	5.0	244	least
521	Tucker	525300	6042700	126	S	400	234	13	-	8.1	5.3	0.032	28	24.5	21.0	3.4	212	least
533	McLean	607818	6259397	128	NE	190	155	18	-	7.9	-	-	22	8.0	5.5	1.5	98	least
522	Ethel	542102	6042790	128	S	302	167	11	-	8.3	4.0	<0.001	29	15.8	12.2	2.7	158	least
523	Hilda	537000	6041000	129	S	670	382	17	-	8.4	15.5	<0.001	21	37.8	73.1	6.7	327	least
450	P99[k]	451402	6281113	130	NNW	151	-	21	30	7.5	2.9	0.100	23	4.2	<0.1	0.7	75	least
546	Cold	560000	6045000	131	SSE	240	155	8	-	8.3	6.5	0.157	31	11.5	9.5	2.1	140	least
451	PF1[k]	445481	6278365	131	NNW	310	-	11	10	7.9	4.0	0.100	53	6.9	2.0	0.5	163	least
456	PF2[k]	448416	6280450	131	NNW	259	-	9	8	7.8	3.3	0.100	43	6.0	2.0	0.3	136	least
457	PF3[k]	442406	6276535	131	NW	247	-	15	25	7.9	3.9	0.100	42	6.3	2.0	0.6	130	least
211	70[f]	388380	6191747	131	W	56	-	33	109	7.3	2.3	<0.001	9	1.8	2.2	0.6	21	low
458	PF4[k]	446055	6279117	131	NNW	369	-	16	35	7.7	5.3	0.100	64	10.2	2.0	0.5	199	least
539	Field	436317	6065106	132	SW	722	443	22	-	8.3	95.5	-	39	29.0	69.1	9.6	231	least
596	Manatokan	503000	6035000	135	S	392	211	16	-	8.7	8.5	0.220	35	27.0	8.5	7.1	203	least
210	69[f]	383412	6181678	135	W	33	-	25	212	6.7	1.2	0.001	5	1.0	1.6	0.3	11	moderate
129	2[f], 15[h], E15(L15b)[g]	506092	6305335	137	N	55	121	38	122	7.0	0.6	0.006	6	1.6	3.8	1.2	22	low
135	3[f], 16[h]	554892	6301050	137	NNE	170	83	17	32	8.7	1.3	0.013	11	5.8	8.4	0.4	89	least
121	59[f], A59[g]	383467	6197733	137	WNW	23	85	30	304	5.2	1.6	0.010	3	0.8	1.2	0.5	3	high
405	P101[k]	448002	6287963	138	NNW	121	-	21	50	7.5	3.7	0.100	16	4.9	<0.1	1.1	61	least

Table 11 Summary of Water Chemistry Data Related to Acid Sensitivity of the 416 Lakes Included in the Assessment (continued)

Lake Identifier(a)	Lake Name / Original Identifier	Easting [UTM](b)	Northing [UTM](b)	Distance [km](c)	Direction(c)	Conductivity [µS/cm]	TDS [mg/L]	DOC [mg/L]	Colour [TCU]	pH	Sulphate [mg/L]	Nitrate + Nitrite [mg/L]	Calcium [mg/L]	Magnesium [mg/L]	Sodium [mg/L]	Potassium [mg/L]	Alkalinity [mg/L as $CaCO_3$]	Acid Sensitivity(d)
212	71(f)	381000	6189159	138	W	54	-	28	204	7.2	5.2	<0.001	8	1.6	2.3	0.4	16	moderate
479	PTH12(k)	491531	6306260	140	N	134	-	25	90	7.6	2.9	<0.001	20	6.2	2.0	0.1	67	least
156	P98(k), P98(g)	451762	6293513	141	NNW	80	110	31	120	7.3	2.2	0.037	12	3.9	0.9	0.6	35	low
214	73(f)	376481	6177226	142	W	54	-	21	188	7.1	3.8	0.150	6	1.9	2.9	0.9	178	least
155	P97(k), P97(g)	456002	6296463	142	NNW	43	86	29	136	6.8	1.4	0.031	6	1.9	0.9	0.8	15	moderate
213	72(f)	376691	6184647	142	W	57	-	20	118	6.7	11.1	<0.001	7	2.1	1.8	0.5	11	moderate
134	1(f), 25(h), 1(267)(g)	441917	6290884	144	NNW	88	67	21	26	7.4	0.9	0.006	11	3.4	1.6	0.9	41	least
200	58(f)	376102	6200433	145	WNW	31	-	29	178	6.5	0.8	<0.001	5	1.2	1.3	0.4	9	high
154	P96(k), P96(g)	444002	6295513	147	NNW	77	92	31	74	7.3	1.7	0.029	10	3.7	0.8	0.9	34	low
416	P30(k)	498500	6314213	147	N	297	300	18	40	7.5	3.6	<0.001	44	9.3	6.0	1.0	155	least
478	PTH11(k)	492308	6313536	147	N	133	-	20	65	7.3	2.5	0.100	18	6.5	3.0	<0.1	68	least
608	Suncor_VS_UW1	472298	6310391	149	NNW	574	307	18	74	7.9	7.3	-0.170	53	20.2	38.0	2.3	200	least
467	PM4(k)	502509	6317128	149	N	144	-	26	120	7.6	2.8	0.100	21	5.6	4.0	0.2	74	least
215	Long (j)	369298	6182079	149	W	87	-	22	145	7.5	4.5	<0.001	12	3.3	3.5	1.0	35	low
425	P47(k)	502300	6317712	150	N	144	-	37	120	7.8	3.2	0.100	21	5.6	3.0	<0.1	73	least
58	Shipyard	473350	6313235	151	NNW	339	246	20	93	7.6	5.3	0.076	45	10.1	14.6	2.0	161	least
449	P95(k)	443552	6301613	152	NNW	162	-	30	160	7.5	5.5	0.100	22	7.1	10.0	0.5	79	least
424	P46(k)	500600	6320312	152	N	213	-	37	70	8.3	2.9	0.100	30	7.9	4.0	<0.1	111	least
140	L5(l), P28(k)	507166	6322123	154	N	61	33	27	109	7.1	2.6	0.051	9	2.4	0.3	0.2	30	low
84	L8(l), L8(g)	524421	6322560	154	N	49	64	19	148	7.0	1.4	<0.001	6	2.3	2.3	0.1	20	moderate
216	75(f)	363259	6189683	156	W	117	-	21	56	8.5	5.3	<0.001	15	5.0	3.5	1.1	50	least
319	L6(l)	510355	6325681	157	N	106	56	21	99	7.7	2.5	0.002	15	4.0	0.5	0.1	52	least
83	L7(l), L7(g)	515032	6327463	159	N	31	30	30	250	6.4	3.7	0.008	4	1.2	0.6	0.2	10	moderate
217	Pelican	358952	6185800	160	W	116	-	26	58	7.9	7.1	<0.001	15	4.6	4.1	1.5	49	least
190	46(f)	370920	6235856	161	WNW	28	-	24	195	6.5	0.6	0.001	4	1.0	0.8	0.3	8	high
161	49(f), A300(g)	366124	6230034	164	WNW	42	64	29	49	7.1	0.2	0.002	6	1.2	1.4	1.4	16	moderate
191	48(f)	367765	6234093	164	WNW	31	-	31	86	7.0	0.5	<0.001	6	0.8	0.8	0.2	10	moderate
329	Mildred	464280	6323724	164	NNW	463	261	7	14	8.2	42.0	0.139	54	15.0	23.0	1.2	179	least
422	P44(k)	522999	6333312	164	N	231	-	51	250	9.0	3.8	0.100	26	9.5	15.0	0.8	126	least
120	47(f), A47(g)	367321	6235430	165	WNW	32	42	15	85	6.4	1.4	0.302	4	0.8	0.7	0.7	8	high
150	P27(k), P27(g)	508300	6333712	165	N	23	66	34	285	5.2	0.8	0.043	3	0.9	0.4	0.1	4	high
82	170(f), 14(h), L4(l), A170(L4)(g)	509075	6334093	165	N	27	23	27	217	6.0	3.8	0.031	3	0.9	0.6	0.2	7	high
423	P45(k)	529099	6334462	166	N	280	-	39	25	8.3	8.2	<0.001	38	12.3	4.0	1.6	144	least
322	L15(l)	548424	6332453	166	N	101	57	36	278	7.5	16.0	<0.001	7	2.5	13.0	0.7	26	low
477	PTH10(k)	495763	6333877	166	N	77	-	20	100	7.0	2.4	0.100	11	3.6	1.0	0.2	35	low
137	Wood Buffalo	368566	6243357	167	WNW	76	51	24	168	6.9	5.2	0.013	9	2.4	2.3	0.4	31	low
535	Turnor	648429	6273616	167	NE	115	91	8	-	7.3	-	-	10	4.0	4.7	1.3	57	least
485	PTH9(k)	495957	6334968	167	N	97	-	17	60	7.4	3.9	0.100	13	4.3	2.0	0.5	47	least
314	Sandy (f)	349626	6188281	169	W	168	-	16	-	8.1	13.4	0.001	22	6.2	3.9	1.6	68	least
193	50(f)	360472	6232476	170	WNW	71	-	31	79	8.4	0.4	<0.001	11	2.5	0.9	0.5	32	low
320	L9(l)	533212	6338082	170	N	154	81	16	54	8.5	2.5	0.002	19	5.0	4.0	0.2	78	least
189	45(f)	363355	6241661	171	WNW	97	-	25	98	8.6	0.7	<0.001	15	3.3	2.6	0.5	45	least
119	42(f), A42(g)	365015	6247322	172	WNW	40	125	38	71	6.8	0.8	0.027	6	1.4	3.4	0.5	14	moderate
414	P25(k)	510500	6340812	172	N	110	-	29	120	7.7	1.9	0.100	17	3.8	2.0	0.1	55	least
445	P9(k)	524699	6341212	172	N	152	-	30	50	7.8	2.2	<0.001	23	5.0	2.0	0.2	75	least
188	44(f)	360775	6241744	173	WNW	86	-	22	95	7.7	0.3	0.002	13	2.8	1.9	0.5	39	low
306	Horsetail	350527	6214242	173	WNW	70	-	15	-	6.9	1.1	0.342	10	2.6	1.0	0.5	29	low
413	P24(k)	505000	6342512	174	N	328	-	20	55	7.8	5.3	<0.001	50	11.0	6.0	1.0	173	least
440	P8(k)	516249	6343212	174	N	58	-	38	300	7.0	1.7	0.100	9	2.1	<0.1	0.2	25	low
152	P7(k), P7(g)	515399	6343212	174	N	27	53	27	258	6.4	0.6	0.025	4	1.3	0.4	0.1	9	high
606	P2	468605	6336285	174	NNW	485	350	19	53	8.2	4.6	0.100	84	14.6	16.5	1.8	269	least
432	P6(k)	512600	6343712	175	N	127	-	30	120	7.7	2.5	0.100	20	4.0	1.0	0.2	64	least
316	D254(j)	374162	6271211	176	NW	164	-	20	-	8.4	3.4	0.001	22	6.3	6.2	0.8	78	least
421	P43(k)	512450	6345512	177	N	82	-	17	40	7.5	2.4	0.100	12	2.9	0.0	0.2	39	low
318	L3(l)	503318	6346085	178	N	85	49	-	-	7.8	2.5	<0.001	14	3.0	0.5	0.1	40	least
149	P23(k), P23(g)	509000	6346712	178	N	66	59	18	124	7.6	1.0	0.026	10	2.4	1.4	0.1	31	low
466	PM3(k)	505393	6346711	178	N	86	-	19	80	7.4	1.7	0.100	13	3.1	<0.1	<0.1	42	least
465	PM2(k)	507264	6347115	178	N	73	-	18	120	7.1	1.2	<0.001	11	2.6	<0.1	0.2	35	low
317	L2(l)	505832	6347134	179	N	107	62	-	-	7.8	2.5	0.010	18	3.0	0.5	0.1	51	least
56	UW6(i)	467296	6340324	179	NNW	256	185	24	25	8.0	8.8	0.100	32	8.9	9.5	1.4	122	least
464	PM1(k)	505194	6347380	179	N	27	-	21	100	4.2	1.1	<0.001	<1	<0.1	<0.1	0.3	3	high
55	UW5(i)	469046	6341224	179	NNW	356	250	16	38	8.2	5.2	0.100	49	10.9	8.0	1.0	173	least
605	P1	468548	6341335	179	NNW	485	300	11	59	8.1	5.5	0.100	77	13.4	8.5	1.3	256	least

Table 11 **Summary of Water Chemistry Data Related to Acid Sensitivity of the 416 Lakes Included in the Assessment (continued)**

Lake Identifier(a)	Lake Name / Original Identifier	Easting [UTM](b)	Northing [UTM](b)	Distance [km](c)	Direction(c)	Conductivity [µS/cm]	TDS [mg/L]	DOC [mg/L]	Colour [TCU]	pH	Sulphate [mg/L]	Nitrate + Nitrite [mg/L]	Calcium [mg/L]	Magnesium [mg/L]	Sodium [mg/L]	Potassium [mg/L]	Alkalinity [mg/L as $CaCO_3$]	Acid Sensitivity(d)
52	UW2(i)	468346	6341324	179	NNW	260	145	9	10	8.1	3.6	0.100	36	7.0	4.5	2.9	131	least
53	UW3(i)	468546	6341424	179	NNW	464	277	13	37	7.9	5.9	0.100	72	12.6	7.7	1.0	235	least
51	UW1(i)	468396	6341424	179	NNW	453	267	14	35	8.0	5.8	<0.001	71	12.6	8.3	1.1	231	least
607	P4	468831	6341793	180	NNW	260	193	14	64	8.0	2.5	0.100	43	7.1	4.3	0.8	141	least
54	UW4(i)	468946	6341924	180	NNW	479	295	18	50	8.2	5.0	<0.001	71	12.4	13.5	1.1	240	least
88	168(f), 12(h), L14(l)	548190	6346767	180	N	112	55	22	34	8.2	1.7	0.009	13	4.2	2.9	0.4	55	least
81	L1(l), L1(g)	504587	6349147	181	N	26	33	<0	38	6.3	3.1	0.006	3	0.9	0.6	0.3	5	high
532	unnamed	635067	6306584	181	NE	91	73	9	-	7.0	-	-	8	3.5	4.3	1.8	43	least
87	167(f), L13(l)	545725	6348186	181	N	80	41	19	49	7.5	1.4	0.044	9	3.0	1.8	0.2	37	low
447	P91(k)	433852	6330512	182	NNW	300	-	24	70	7.7	6.7	<0.001	33	12.1	14.0	2.1	156	least
153	P94(k), P94(g)	440557	6334112	182	NNW	117	165	48	137	7.4	12.4	0.030	13	5.4	6.6	1.3	40	low
20	Isadore's	463522	6343138	182	NNW	456	284	11	27	7.9	54.9	0.067	54	22.9	7.0	1.8	186	least
446	P90(k)	436852	6332462	182	NNW	231	-	26	70	7.9	5.2	0.100	24	8.7	13.0	2.7	122	least
86	166(f), L12(l)	544341	6349563	183	N	90	46	27	50	8.9	1.5	<0.001	11	3.6	2.9	0.2	42	least
4	Kearl	485939	6349881	184	N	187	132	22	70	8.0	4.9	0.039	20	7.2	10.8	1.0	95	least
187	41(f)	355095	6256783	185	WNW	134	-	22	100	7.8	6.9	<0.001	14	4.6	9.4	0.4	56	least
420	P4(k)	479201	6352812	188	NNW	372	-	20	15	8.2	3.8	<0.001	41	14.4	18.0	1.1	185	least
78	UNL-1(i)	485427	6357465	191	N	514	337	17	40	8.2	5.0	<0.001	72	31.4	3.0	1.0	293	least
304	D226(j)	351247	6264347	192	WNW	264	-	23	-	8.2	50.7	<0.001	33	8.9	9.6	2.2	73	least
415	P3(k)	483501	6360762	195	N	328	-	20	55	7.8	5.3	<0.001	50	11.0	6.0	1.0	173	least
79	UNL-2(i)	494650	6362557	195	N	514	337	17	40	8.2	5.0	0.100	72	31.4	3.0	1.0	293	least
419	P38(k)	518699	6364212	195	N	87	-	16	30	7.5	1.4	0.100	12	4.3	1.0	<0.1	43	least
321	L11(l)	543215	6362610	195	N	59	34	28	68	8.1	2.5	0.002	8	2.5	0.5	0.1	28	low
284	Big Snuff	542056	6363054	196	N	68	-	17	47	7.5	0.1	0.008	9	3.7	1.3	0.1	30	low
302	D223(j)	361754	6287198	196	NW	147	-	32	-	9.3	16.2	<0.001	17	7.1	4.3	2.0	49	least
411	P2(k)	481401	6362412	197	N	285	-	16	25	8.3	9.2	0.100	42	11.8	1.0	0.7	148	least
80	P5(k), UNL-3(i)	499429	6365047	197	N	268	193	13	60	7.9	2.6	0.100	38	13.6	1.9	0.9	145	least
373	22(h)	361308	6293772	200	NW	278	143	-	-	7.7	21.0	0.025	20	6.0	21.0	1.6	120	least
85	164(f), 17(h), L10(l)	533760	6369378	201	N	142	73	11	8	8.6	1.7	0.009	16	6.1	1.2	0.3	73	least
534	Proudfoot	657119	6314790	202	NE	44	30	14	-	7.0	-	-	3	1.7	2.0	1.0	19	moderate
300	D221(j)	365323	6302862	203	NW	481	-	38	-	8.6	15.0	0.001	30	22.4	49.1	11.9	240	least
19	Calumet	453963	6363973	205	NNW	633	473	51	188	7.8	41.2	<0.001	48	18.0	74.7	4.8	263	least
12	LK-7(i)	455211	6364522	205	NNW	255	185	30	55	7.7	3.8	0.100	30	10.1	4.5	2.0	130	least
89	Rabbit	381972	6323180	206	NW	315	171	53	76	8.4	16.5	0.015	22	11.5	28.0	4.5	146	least
488	PW3(k)	412268	6345506	206	NNW	117	-	17	50	7.3	6.4	0.100	13	3.6	2.0	3.8	54	least
5	McClelland	480016	6371236	206	N	259	150	13	9	8.3	5.5	0.063	24	16.8	4.6	3.0	132	least
283	163(f)	506991	6374911	206	N	172	-	19	27	8.4	0.1	0.001	22	10.0	0.8	0.2	86	least
18	Lillian	455932	6365954	206	NNW	479	318	23	61	7.6	3.1	0.125	66	18.5	8.8	2.3	262	least
406	P11(k)	423003	6353012	207	NNW	110	-	32	300	7.4	7.4	<0.001	10	4.4	10.0	0.9	47	least
336	L51(l)	399507	6338927	207	NW	125	66	28	71	8.5	5.0	0.001	14	5.0	6.0	1.4	57	least
484	PTH8(k)	510279	6375937	207	N	127	-	25	70	7.7	2.2	0.100	16	8.5	<0.1	<0.1	65	least
487	PW2(k)	419555	6351513	207	NNW	233	-	31	140	7.9	13.3	0.100	26	9.0	17.0	1.1	113	least
301	D222(j)	349070	6289492	207	NW	327	-	36	-	8.7	22.4	0.001	42	14.6	9.2	5.7	147	least
337	L52(l)	399323	6341684	209	NW	152	81	21	41	7.4	17.0	0.136	14	4.4	6.0	3.1	58	least
418	P35(k)	510100	6378311	209	N	143	-	20	20	8.1	1.8	0.100	17	7.8	<0.1	0.3	73	least
407	P14(k)	418303	6353462	210	NNW	177	-	37	400	7.6	24.5	<0.001	22	6.9	9.0	0.8	65	least
282	162(f)	513963	6378636	210	N	228	-	15	21	8.0	-	0.001	28	12.4	1.3	0.4	113	least
486	PW1(k)	414747	6351741	210	NNW	134	-	31	300	7.2	23.2	0.200	14	5.6	7.0	1.6	38	low
483	PTH7(k)	511202	6379065	210	N	204	-	24	60	8.0	3.5	0.100	24	13.7	<0.1	<0.1	105	least
443	P86(k)	411153	6350112	210	NNW	360	-	31	100	7.7	51.1	0.100	39	10.9	22.0	2.2	139	least
148	P13(k), P13(g)	416003	6353212	211	NNW	108	144	45	138	8.0	6.6	0.028	11	4.5	8.2	0.7	44	least
339	L54(l)	391449	6339131	212	NW	374	213	23	150	7.6	44.0	0.048	43	13.0	15.0	1.8	157	least
338	L53(l)	396115	6344270	213	NW	385	228	28	65	7.4	87.0	0.480	44	11.7	17.0	2.2	105	least
409	P17(k)	428803	6363212	214	NNW	171	-	29	120	7.3	31.7	<0.001	21	5.6	7.0	1.8	52	least
417	P34(k)	514199	6382911	214	N	163	-	24	90	7.8	2.5	0.100	20	11.0	<0.1	<0.1	83	least
6	LK-1(i)	457730	6374675	214	NNW	1,453	1,037	41	23	9.1	87.9	0.100	11	104.7	215.7	28.3	801	least
408	P16(k)	427803	6363462	214	NNW	122	-	33	250	6.9	32.6	0.100	15	4.3	5.0	0.9	23	low
410	P18(k)	429003	6364212	215	NNW	141	-	22	60	7.5	27.6	0.100	15	4.5	5.0	2.2	39	low
482	PTH6(k)	514631	6383486	215	N	182	-	25	70	7.8	3.2	0.100	23	10.9	<0.1	0.3	92	least
281	161(f)	528885	6384281	216	N	234	-	16	8	8.5	-	0.002	24	13.6	4.7	1.2	115	least
102	33(h), L33(l)	425151	6365349	217	NNW	268	146	15	29	8.4	18.0	0.014	35	9.0	5.0	2.2	129	least
526	Preston	612119	6365312	218	NNE	49	40	3	-	6.8	-	<0.001	4	1.8	2.8	1.0	25	low
481	PTH5(k)	513190	6386987	218	N	256	-	18	30	8.0	2.8	0.100	29	12.6	5.0	1.2	122	least

Table 11 Summary of Water Chemistry Data Related to Acid Sensitivity of the 416 Lakes Included in the Assessment (continued)

Lake Identifier(a)	Lake Name / Original Identifier	Easting [UTM](b)	Northing [UTM](b)	Distance [km](c)	Direction(c)	Conductivity [µS/cm]	TDS [mg/L]	DOC [mg/L]	Colour [TCU]	pH	Sulphate [mg/L]	Nitrate + Nitrite [mg/L]	Calcium [mg/L]	Magnesium [mg/L]	Sodium [mg/L]	Potassium [mg/L]	Alkalinity [mg/L as $CaCO_3$]	Acid Sensitivity(d)
475	PT9(k)	436094	6371181	218	NNW	119	-	16	50	7.9	4.7	0.100	15	4.7	2.0	1.3	56	least
278	157(f)	508959	6386971	218	N	307	-	19	34	8.3	0.2	0.001	39	14.6	5.0	1.1	148	least
280	160(f)	527874	6387057	218	N	184	-	14	22	8.3	0.2	<0.001	23	9.3	1.9	0.5	90	least
528	Lloyd	624328	6360129	219	NNE	39	23	4	-	6.9	-	<0.001	3	1.0	1.4	1.0	15	moderate
103	Audet	504973	6388824	220	N	304	165	18	21	8.2	2.5	0.009	32	16.1	6.5	2.2	147	least
374	Carrot	354281	6317284	221	NW	200	100	-	-	7.3	8.0	0.025	20	6.0	7.0	1.6	93	least
104	Johnson	536807	6389912	222	N	300	150	14	30	8.4	2.3	0.009	33	15.7	6.4	1.1	148	least
279	158(f)	527848	6390764	222	N	254	-	17	17	8.5	-	0.001	25	17.4	2.9	1.0	128	least
299	Chipewyan	350513	6315437	222	NW	215	-	14	-	8.9	10.3	0.007	24	9.2	9.1	2.3	103	least
10	LK-5(i)	444669	6379654	223	NNW	207	140	11	28	7.5	30.4	0.100	21	7.7	7.0	2.9	71	least
341	L56(l)	375397	6341720	224	NW	91	47	21	110	7.2	8.0	0.003	11	3.0	3.0	0.8	35	low
444	P87(k)	426003	6373212	224	NNW	71	-	18	120	7.3	3.2	0.100	11	3.2	<0.1	0.0	33	low
442	P85(k)	422403	6371812	224	NNW	71	-	24	160	7.2	5.6	0.100	11	3.1	<0.1	0.2	29	low
17	LK-12(i)	445617	6381379	224	NNW	151	121	17	80	7.2	25.4	0.100	16	6.5	2.7	1.2	44	least
340	L55(l)	376224	6344078	225	NW	174	92	13	21	7.8	13.0	0.003	22	6.0	4.0	1.3	77	least
441	P84(k)	416203	6370462	226	NNW	68	-	18	120	7.1	3.2	0.100	10	3.3	<0.1	0.5	31	low
11	LK-6(i)	444494	6382690	226	NNW	189	127	12	43	7.5	26.4	0.100	24	7.0	2.7	1.6	65	least
474	PT8(k)	445573	6383359	226	NNW	176	-	13	50	7.8	31.8	0.100	19	7.0	3.0	1.5	50	least
436	P70(k)	429803	6377462	226	NNW	38	-	29	150	6.6	2.1	0.100	6	1.8	<0.1	0.2	14	moderate
7	LK-2(i)	440554	6382003	227	NNW	30	55	14	138	6.7	1.8	0.100	4	1.2	<0.1	0.3	10	moderate
430	P52(k)	461502	6391111	229	NNW	439	-	30	35	8.3	52.7	<0.001	32	27.5	17.0	13.6	180	least
473	PT6(k)	460733	6391206	229	NNW	345	-	33	50	8.4	27.3	<0.001	36	18.5	8.0	6.2	157	least
91	Namur	402704	6368016	230	NNW	62	38	10	13	7.2	7.1	0.003	6	2.0	2.4	1.1	21	low
426	P48(k)	447802	6388211	230	NNW	116	-	24	100	7.7	14.7	0.100	12	4.7	6.0	0.4	41	least
525	Forrest	604633	6383668	232	NNE	55	39	2	-	6.9	-	-	4	1.8	2.0	1.0	24	low
323	S. Gardiner	410108	6374038	232	NNW	109	57	10	59	7.6	6.0	0.002	14	4.0	2.0	0.8	53	least
277	153(f)	513886	6400901	232	N	100	-	17	40	8.7	-	<0.001	14	4.0	1.3	0.5	47	least
346	Canopener	420461	6379858	232	NNW	142	72	21	132	7.6	1.5	<0.001	20	6.0	2.0	0.5	69	least
345	Buoy	418473	6380143	233	NNW	202	107	12	24	8.3	6.0	0.017	27	8.0	3.0	1.1	104	least
524	Patterson	598819	6389537	235	NNE	42	30	3	-	6.9	-	-	4	1.2	1.4	1.0	19	moderate
428	P50(k)	444752	6392311	235	NNW	230	-	15	80	8.2	7.5	0.100	30	10.6	3.0	0.5	118	least
434	P61(k)	425103	6385111	235	NNW	79	-	23	125	7.5	2.5	0.200	11	3.4	<0.1	0.5	35	low
429	P51(k)	451552	6394711	235	NNW	126	-	13	150	7.3	23.7	<0.001	12	4.9	3.0	2.1	34	low
324	N. Gardiner	410554	6378483	235	NNW	117	61	15	64	7.8	6.0	0.002	15	4.0	2.0	0.8	53	least
412	P20(k)	438802	6390961	236	NNW	67	-	26	150	7.5	3.2	0.100	9	3.1	1.0	<0.1	29	low
431	P54(k)	451302	6395711	236	NNW	110	-	5	20	7.8	10.9	0.100	11	5.0	2.0	0.8	44	least
472	PT5(k)	448974	6395163	236	NNW	61	-	21	150	7.5	1.9	0.100	8	2.9	<0.1	0.5	28	low
435	P69(k)	427503	6387611	237	NNW	55	-	26	125	7.4	1.8	0.100	8	2.8	1.0	0.2	23	low
438	P77(k)	438202	6391811	237	NNW	65	-	27	125	7.1	2.7	0.100	10	2.8	<0.1	<0.1	28	low
439	P79(k)	438752	6392211	237	NNW	63	-	30	150	7.0	2.8	0.100	10	2.6	<0.1	<0.1	26	low
471	PT4(k)	438235	6392291	237	NNW	77	-	28	125	7.6	3.0	<0.001	12	3.2	<0.1	<0.1	34	low
151	P49(k), P49(g)	446002	6394961	237	NNW	25	32	17	69	6.7	1.4	0.026	3	1.3	1.2	0.4	9	high
93	Legend	383849	6364923	237	NW	29	19	10	29	6.9	2.8	0.011	3	0.7	0.7	0.6	11	moderate
470	PT3(k)	433955	6393613	240	NNW	75	-	30	150	7.5	3.8	0.100	10	3.4	1.0	0.2	30	low
527	Beet	611405	6391278	241	NNE	45	35	3	-	6.9	-	-	4	1.5	2.0	1.0	22	low
325	L21(l)	410374	6386071	242	NNW	106	56	<1	15	7.9	10.0	0.002	11	3.5	4.0	1.0	44	least
326	Sand	418434	6390656	243	NNW	105	55	16	79	8.0	2.5	0.003	14	4.0	2.0	0.7	52	least
433	P60(k)	437402	6398711	243	NNW	110	-	22	125	7.7	4.7	<0.001	14	5.6	3.0	0.6	50	least
333	L45(l)	491985	6411117	244	N	141	91	9	19	8.0	2.5	0.001	17	8.0	0.5	0.4	75	least
334	L48(l)	429234	6396488	244	NNW	114	59	29	124	7.4	1.5	<0.001	16	4.0	2.0	0.3	58	least
328	Clear	433258	6399414	245	NNW	83	57	21	125	7.4	2.5	0.010	12	4.5	0.5	0.3	37	low
468	PT1(k)	429874	6398738	246	NNW	115	-	19	100	8.0	6.2	0.100	14	5.3	<0.1	<0.1	50	least
476	PTH1(k)	511576	6415521	247	N	229	-	10	10	8.3	5.8	0.100	27	12.4	1.0	0.7	118	least
437	P72(k)	428903	6400411	248	NNW	58	-	33	150	5.9	13.6	0.100	4	2.1	4.0	0.3	8	high
469	PT2(k)	430065	6401484	249	NNW	51	-	30	250	5.0	12.2	<0.001	4	1.7	2.0	0.2	3	high
271	145(f)	511855	6417594	249	N	242	-	-	5	8.4	2.0	0.001	30	12.1	1.2	0.9	121	least
108	Waterlily	407519	6391915	249	NNW	70	33	22	198	7.7	8.8	0.007	7	2.4	3.5	0.6	22	low
92	Otasan	417321	6396959	249	NNW	25	37	12	49	6.7	1.4	0.002	3	1.0	0.8	0.4	8	high
344	L59(l)	393655	6384983	249	NNW	54	33	28	270	7.3	4.0	0.004	6	2.0	2.0	0.4	18	moderate
343	L58(l)	373071	6372273	250	NW	101	51	19	42	9.3	1.5	0.005	13	4.0	1.0	0.1	50	least
275	151(f)	541491	6417792	250	N	41	-	13	117	7.2	1.0	0.000	4	1.6	2.2	0.8	15	moderate
107	L60(l), L60(g)	403796	6392247	251	NNW	58	67	18	153	7.2	8.7	0.013	6	2.1	2.7	0.6	15	moderate
480	PTH2(k)	513560	6419693	251	N	226	-	9	10	8.1	4.8	<0.001	29	11.0	1.0	0.5	116	least

Table 11 Summary of Water Chemistry Data Related to Acid Sensitivity of the 416 Lakes Included in the Assessment (continued)

Lake Identifier(a)	Lake Name / Original Identifier	Easting [UTM](b)	Northing [UTM](b)	Distance [km](c)	Direction(c)	Conductivity [µS/cm]	TDS [mg/L]	DOC [mg/L]	Colour [TCU]	pH	Sulphate [mg/L]	Nitrate + Nitrite [mg/L]	Calcium [mg/L]	Magnesium [mg/L]	Sodium [mg/L]	Potassium [mg/L]	Alkalinity [mg/L as $CaCO_3$]	Acid Sensitivity(d)
342	L57(l)	365956	6368725	251	NW	120	67	31	2	7.7	5.0	<0.001	19	5.0	2.0	0.1	58	least
327	Eaglenest	432609	6405149	251	NNW	81	55	19	167	7.5	2.5	0.010	11	4.0	2.0	0.5	34	low
270	143(f)	498027	6419437	251	N	171	-	-	5	8.1	1.9	0.001	22	7.6	1.3	0.6	83	least
99	144(f), L43(l)	499704	6419587	251	N	160	89	2	6	8.1	2.2	0.001	20	7.4	0.9	0.6	81	least
332	L44(l)	494569	6419374	251	N	150	92	7	3	8.7	2.5	0.001	16	9.5	0.5	0.6	99	least
274	149(f)	522212	6420422	251	N	227	-	6	7	8.3	0.8	<0.001	34	8.6	1.0	0.6	134	least
276	152(f)	519738	6421333	252	N	198	-	-	7	8.3	0.6	<0.001	29	7.0	1.0	0.6	99	least
273	148(f)	521711	6422278	253	N	156	-	-	7	8.2	0.5	<0.001	23	5.7	0.9	0.6	78	least
98	146(f), L40(l)	519356	6422417	253	N	119	73	6	3	8.0	1.5	0.001	16	3.9	0.8	0.6	61	least
330	L41(l)	509160	6422381	254	N	159	84	13	1	7.8	6.0	0.007	20	7.0	0.5	0.6	81	least
105	150(f), 9(h), L39(l), A-150(L39)(g)	536495	6424234	256	N	32	46	14	78	6.8	2.0	0.005	3	1.3	2.2	0.6	13	moderate
106	Bayard	416941	6404239	256	NNW	60	69	21	260	6.7	10.3	0.067	6	2.0	3.5	0.8	14	moderate
269	142(f)	505917	6424695	256	N	194	-	7	9	8.3	1.4	<0.001	26	8.5	1.2	0.7	97	least
268	141(f)	503947	6424693	256	N	198	-	-	4	8.3	1.3	<0.001	26	8.9	1.2	0.8	98	least
262	Dianne	463961	6419598	256	NNW	300	-	15	48	7.9	27.7	<0.001	37	10.1	10.2	3.3	119	least
100	27(h), L47(l), L47(g)	396500	6395456	257	NNW	57	67	20	142	6.7	9.4	0.098	8	2.5	3.0	1.0	14	moderate
335	L50(l)	392149	6393777	258	NNW	78	42	30	136	7.0	11.0	<0.001	7	4.0	3.0	0.2	26	low
267	139(f)	499012	6425927	258	N	134	-	6	3	8.1	0.8	<0.001	17	5.6	1.3	0.7	66	least
265	Pearson	486197	6425027	258	N	169	-	-	4	8.1	1.3	<0.001	22	6.7	1.7	0.5	80	least
331	L42(l)	501166	6427071	259	N	184	104	5	6	8.1	2.5	0.001	24	8.5	0.5	0.6	100	least
272	Poplar	522662	6427850	259	N	199	-	8	10	8.4	1.1	<0.001	31	7.6	1.2	0.8	99	least
266	Kress	492117	6426859	259	N	100	-	8	23	7.9	0.1	<0.001	12	3.9	2.5	0.5	46	least
101	L49(l), L49(g)	404995	6403111	260	NNW	61	73	20	191	6.6	14.6	0.107	5	1.8	3.7	0.8	9	high
264	136(f)	484228	6426882	260	N	185	-	-	3	8.0	0.2	<0.001	26	6.3	2.2	1.2	92	least
263	134(f)	467958	6426055	262	N	261	-	6	12	8.1	-	<0.001	34	9.6	5.6	1.2	122	least
260	131(f)	458576	6424282	262	NNW	383	-	11	27	8.0	56.0	0.004	50	13.7	10.1	2.7	135	least
261	Ronald	460556	6425197	263	NNW	367	-	13	26	8.0	34.1	0.025	43	12.2	14.3	3.4	137	least
351	L68(l)	413276	6411466	264	NNW	40	25	40	347	6.9	6.0	0.005	5	1.0	3.0	0.3	11	moderate
352	L69(l)	419591	6414486	264	NNW	230	124	28	103	8.0	10.0	0.003	33	6.0	8.0	0.8	109	least
348	Currie	515504	6436008	267	N	82	41	7	3	7.3	1.5	0.004	8	1.6	2.0	1.0	42	least
95	29(h), L27(l)	362195	6386208	267	NW	34	20	23	231	6.3	4.3	0.018	5	0.5	0.5	0.7	8	high
350	Harwood	536958	6436149	268	N	60	31	7	12	7.7	1.5	0.002	5	3.0	1.0	0.5	34	low
349	Archer	539134	6441490	273	N	46	24	10	15	7.8	1.5	0.018	4	2.0	1.0	0.4	25	low
347	L64(l)	514035	6443734	275	N	90	46	8	47	7.9	1.5	0.002	12	3.0	1.0	0.4	50	least
96	28(h), L28(l), L28(g)	382996	6414339	280	NNW	21	56	24	423	5.2	2.2	0.023	2	0.6	1.1	0.3	3	high
97	Clayton	424694	6435790	283	NNW	17	33	16	203	4.3	0.6	0.002	1	0.2	0.8	0.1	<1	high
529	Sandy(j)	573917	6468241	304	N	218	-	-	-	7.3	-	-	17	9.2	6.1	1.2	-	-
531	Cluff	595873	6468054	309	NNE	155	-	-	-	8.1	-	-	15	8.9	1.7	0.7	-	-

(a) Identifier used on map showing lake locations.

(b) Universal Transverse Mercator (UTM) co-ordinates are North American Datum (NAD83), Zone 12.

(c) Distance and direction relative to the MEG Christina Lake Regional Project (CLRP).

(d) Acid Sensitivity using categories as defined by Saffran and Trew (1996).

(e) Identifier used in the Water Quality Baseline Report for this study (Volume 4, Appendix 4-IV).

(f) Identifier used by previous EIAs, refer to Section 5.3, Table 14.

(g) Identifier used by RAMP (2004).

(h) Identifier used by Erickson (1987).

(i) Identifier used by Saffran and Trew (1996).

(j) Identifier used by Syncrude (2000).

(k) Identifier used by WRS (2004) for one hundred ponds sampled within Oil Sands Region during September 2000.

(l) Identifier used by WRS (2004) for a survey of 34 lakes conducted by Alberta-Pacific Forest Industries in 1999.

– = No data or not applicable.

5.1.2 Streams

5.1.2.1 Alkalinity of Local Streams and Rivers

The limited available alkalinity data for streams and rivers in the Local Study Area (LSA) (Table 12) suggest that the degree of sensitivity to episodic acidification is low in the Project area. Alkalinity values vary between 26 and 159 mg/L as $CaCO_3$, which correspond to 520 and 3,180 µeq/L, respectively (Table 11). All values are above 200 µeq/L, which is the upper limit of the ANC range considered indicative of acid sensitivity in streams (Boward et al. 1999).

Table 12 Summary of Available Alkalinity and pH Data for Streams and Rivers Near the Project

River/Stream			Parameter	Units	Spring	Summer	Fall	Minimum Alkalinity [µeq/L]
Local Surface Waters	MEG CLRP Phase 3	Unnamed Watercourse 1-07	pH (field)	n/a	6.9	7.6	7.4	940
			pH (lab)	n/a	7.6	7.9	7.6	
			alkalinity	mg/L	47	83	89	
			alkalinity	µeq/L	940	1,660	1,780	
		Unnamed Watercourse 2-07	pH (field)	n/a	6.3	7.2	6.9	1,380
			pH (lab)	n/a	7.6	7.9	7.9	
			alkalinity	mg/L	69	102	100	
			alkalinity	µeq/L	1,380	2,040	2,000	
		Unnamed Watercourse 3-07	pH (field)	n/a	–	6.9	7.3	700
			pH (lab)	n/a	7.5	7.5	7.4	
			alkalinity	mg/L	35	50	43	
			alkalinity	µeq/L	700	1000	860	
		Unnamed Watercourse 4-07 (“Sawbones Creek”)	pH (field)	n/a	6.6	7.3	6.9	1,240
			pH (lab)	n/a	7.8	7.8	8	
			alkalinity	mg/L	62	121	104	
			alkalinity	µeq/L	1,240	2,420	2,080	
		Unnamed Watercourse 1-04	pH (field)	n/a	7.3	7.2	7.2	520
			pH (lab)	n/a	7.6	7.9	7.9	
			alkalinity	mg/L	26	61	46	
			alkalinity	µeq/L	520	1220	920	
		Unnamed Watercourse 6-04	pH (field)	n/a	7.6	7.5	7.5	1,820
			pH (lab)	n/a	8.1	8.1	7.9	
			alkalinity	mg/L	91	159	96	
			alkalinity	µeq/L	1,820	3,180	1,920	
		Unnamed Watercourse 10-04	pH (field)	n/a	–	6.9	7.5	1,000
			pH (lab)	n/a	–	7.7	7.7	
			alkalinity	mg/L	–	50	70	
			alkalinity	µeq/L	–	1,000	1,400	

– = No data; CLRP = Christina Lake Regional Project; n/a = not applicable.

Source: Volume 4, Appendix 4-IV.

5.1.2.2 Watershed Characteristics

Watershed characteristics in the RSA are also mostly inconsistent with those considered to predispose streams to episodic acidification (i.e., high elevation, steep topography, large areas of exposed bedrock, deep snowpack and shallow, base-poor soils; Sullivan 2000). The topography of the RSA is generally flat, with the exception of the Athabasca River escarpment and the Birch Mountains, and therefore tends to release meltwaters slowly. Exposed bedrock is rare. The Oil Sands Region is generally not prone to weather events triggering rapid snowmelt, but is rather characterized by gradual warming during the spring.

5.1.2.3 Climatic Characteristics

Based on climate normals for northeastern Alberta (Environment Canada 1998), snowpack accumulation in the RSA can be qualitatively classified as “low to moderate”. The long-term average annual snowfall is about 120 cm in this region, with a resulting snowpack that would be considerably lower due to compaction. About 30% of the total annual average precipitation falls as snow in this region.

5.1.2.4 Monitoring of Acid Pulses

Spring acid pulses of low magnitude have been observed in the Oil Sands Region. AENV monitored acid pulse periodically between 1989 and 2001 in the Firebag, Muskeg and Steepbank rivers, as well as in outflows from lakes L4 and L7 (1999 only) (WRS 2002). Spring acid pulses were observed in the Firebag and Steepbank rivers (WRS 2002) and small pH depressions were recorded in the Muskeg River in 1989 and 1998.

Analysis of the data collected during acid pulse studies by WRS (2002) revealed that more than 90% of the ANC decline during acid pulses could be attributed to dilution by melt waters. Naturally occurring organic acids accounted for up to 6.5% of the ANC decline. Nitrate loading was not a significant factor and was found to contribute to ANC in stream water. The maximum ANC decline attributable to sulphate (presumably derived from air emissions) was 4.5% in the Firebag River, but the effect of sulphate on ANC was typically less than 1%. The peaks in $H+$ ion concentrations observed in most of the rivers were very small, and usually represented drops in pH of less than 0.5 pH units. It was noted that the pH and buffering capacity of the rivers studied were relatively high and that the degree of pH depression during acid pulses was too small to represent significant threat to aquatic biota.

5.1.2.5 Summary

In summary, available water chemistry data and watershed characteristics in the RSA are not indicative of a high degree of stream sensitivity to episodic acidification. According to WRS (2002) spring acid pulses observed in the Oil Sands Region during recent AENV studies were almost entirely attributable to natural factors.

5.2 BACKGROUND ACID INPUT RATES

Background lake net PAI values estimated from lake water quality data and corresponding modelled background acid deposition rates are provided in Table 13.

Although there are some exceptions, lake water quality data suggest that present-day nitrogen and sulphate input rates are typically much lower than the background nitrate deposition rates estimated by AENV, because watershed processes are retaining nitrogen and sulphate, as expected. Estimated background acid input from N ranges from less than 0.0001 to 0.04 keq/ha/yr, whereas AENV's estimates of deposition rates from the RELAD model range from 0.07 to 0.11 keq/ha/yr. Estimated present day sulphate input rates range from less than 0.001 to greater than 2 keq/ha/yr, with more than 95% of predicted sulphate inputs less than 0.5 keq/ha/yr. AENV estimates of deposition rate from the RELAD model range from 0.08 to 0.13 keq/ha/yr. There are a small number of lakes with relatively high sulphate measurements. In these lakes, sulphate concentrations are not related to acidity because the lakes have high alkalinity and pH values.

Table 13 Modelled Background Acid Deposition Rates, Estimated Background Lake Net Potential Acid Input and Data Used to Calculate Background Lake Net Potential Acid Input from Sulphate and Nitrate for the 416 Lakes Included in the Assessment

Lake Identifier(a)	Lake Name/Original Identifier	Distance [km](b)	Direction(b)	Gross Catchment Area [km^2]	Net Annual Inflow [m^3/s]	Sulphate [mg/L]	Nitrate + Nitrite [mg/L]	Modelled Sulphate Background Deposition [keq/ha/yr](c)	Estimated Background Acid Input from Sulphate [keq/ha/yr](d)	Modelled Nitrate Background Deposition [keq/ha/yr](c)	Estimated Background Acid Input from Nitrate [keq/ha/yr](d)
618	Unnamed WB 9-04(e)	2	W	2.1	0.004	1.5	–	0.098	0.021	0.088	–
617	Unnamed WB 7-04(e)	3	WNW	2.2	0.005	1.3	0.050	0.098	0.018	0.088	–
616	Unnamed WB 8-04(e)	3	W	2.4	0.005	1.1	–	0.098	0.015	0.088	–
620	Unnamed WB 11-04(e)	4	E	8.7	0.018	1.1	0.050	0.098	0.015	0.088	–
609	Unnamed WB 2-07(e)	5	NE	1.8	0.004	2.1	0.050	0.098	0.029	0.088	–
614	Unnamed WB 15-04(e)	5	WSW	0.7	0.001	1.1	–	0.098	0.015	0.088	–
231	95(f), Unnamed WB 6-04(e)	7	N	16.1	0.059	1.0	0.038	0.098	0.025	0.088	0.003
615	Unnamed WB 5-04(e)	8	NNW	5.6	0.012	0.8	–	0.098	0.010	0.088	–
610	Unnamed WB 3-07(e)	8	W	15.7	0.033	0.7	0.050	0.098	0.010	0.088	–
621	Unnamed WB 13-04(e)	9	SE	12.3	0.026	1.4	–	0.098	0.019	0.088	–
2	Christina	9	SW	1,233.5	2.809	5.4	0.031	0.098	0.081	0.088	0.002
612	Unnamed WB 2-04(e)	9	W	2.1	0.004	0.8	–	0.098	0.010	0.088	–
613	Unnamed WB 16-04(e)	10	WNW	6.6	0.014	1.1	–	0.098	0.015	0.088	–
611	Unnamed WB 4-07(e)	10	ENE	6.0	0.013	0.8	0.067	0.098	0.011	0.088	–
147	94(f), 94(354)(g),Unnamed WB 1-07(e)	10	NNW	8.5	0.016	1.0	0.023	0.098	0.012	0.088	0.001
232	97(f), Unnamed WB 12-04(e)	11	E	51.5	0.201	0.7	0.038	0.098	0.017	0.088	0.003
233	98(f)	16	WSW	25.8	0.092	0.5	0.001	0.098	0.011	0.088	<0.001
241	108(f)	21	SSW	51.1	0.171	0.5	<0.001	0.115	0.011	0.103	<0.001
240	Kirby	22	S	22.4	0.061	0.2	<0.001	0.115	0.004	0.103	<0.001
237	Winefred, WB-WL(e)	23	SE	1,185.9	4.087	1.4	0.040	0.112	0.031	0.101	0.003
230	93(f)	24	NE	11.3	0.039	0.6	0.001	0.096	0.013	0.086	<0.001
227	Bohn	28	N	200.8	0.565	1.4	<0.001	0.098	0.027	0.088	<0.001
235	101(f)	31	E	6.5	0.021	-	<0.001	0.096	-	0.086	<0.001
234	100(f)	31	ENE	49.6	0.205	0.2	0.001	0.096	0.005	0.086	<0.001
229	Cowper	31	NNE	280.5	0.912	0.9	<0.001	0.096	0.020	0.086	<0.001
228	90(f)	31	NNE	19.9	0.062	1.8	<0.001	0.098	0.037	0.088	<0.001
238	104(f)	34	SE	8.7	0.029	0.3	0.001	0.112	0.006	0.101	<0.001
132	Grist	35	SSE	118.2	0.433	2.0	0.013	0.112	0.047	0.101	0.001
239	106(f)	36	SSE	3.5	0.006	0.2	0.001	0.115	0.002	0.103	<0.001
139	91(f), 7(h)	39	NNE	315.9	1.009	1.6	<0.001	0.096	0.034	0.086	0.001
186	40(f)	40	N	27.8	0.095	3.3	0.002	0.098	0.075	0.088	<0.001
244	113(f)	40	SW	35.1	0.148	0.2	<0.001	0.115	0.005	0.103	<0.001
46	UNL4(i)	40	SSW	0.9	0.002	1.3	0.075	0.115	0.014	0.103	0.003
44	UNL1(i)	41	SW	72.0	0.254	2.1	0.083	0.115	0.050	0.103	0.007
236	102(f)	41	E	16.1	0.061	0.5	<0.001	0.096	0.012	0.086	<0.001
45	UNL3(i)	42	SSW	3.7	0.014	0.9	0.075	0.115	0.022	0.103	0.006
50	UNL13(i)	42	SW	2.0	0.008	2.1	<0.001	0.115	0.051	0.103	0.008
49	UNL12(i)	42	SW	1.8	0.007	1.0	0.100	0.115	0.024	0.103	0.008
48	UNL7(i)	44	SW	1.5	0.005	1.3	0.075	0.115	0.026	0.103	0.005
47	UNL5(i)	44	SSW	5.1	0.017	0.8	0.075	0.115	0.018	0.103	0.006
43	Ipiatik	46	SSW	56.0	0.182	1.5	0.100	0.115	0.032	0.103	0.007
42	Wiau	47	SW	339.0	1.117	1.2	0.063	0.115	0.025	0.103	0.005
243	111(f)	49	WSW	24.6	0.091	0.4	<0.001	0.115	0.009	0.103	<0.001
222	81(f)	55	NW	40.0	0.187	0.2	0.002	0.098	0.006	0.088	<0.001
167	Wappau	57	WSW	75.9	0.190	0.2	<0.001	0.095	0.003	0.085	<0.001
242	110(f)	58	WSW	11.7	0.040	0.3	0.001	0.117	0.007	0.105	<0.001
245	114(f)	59	WSW	7.2	0.024	0.2	<0.001	0.117	0.004	0.105	<0.001
180	33(f)	60	NNW	14.2	0.067	0.6	0.001	0.098	0.018	0.088	<0.001
184	Watchusk	61	NNE	301.8	0.883	0.9	<0.001	0.096	0.017	0.086	<0.001
130	32(f), 2(h)	62	NNW	30.4	0.128	1.4	0.017	0.098	0.037	0.088	0.002
136	34(f), 1(h)	63	NW	73.8	0.301	1.4	0.013	0.098	0.037	0.088	0.001
248	Clyde	63	SW	470.3	0.488	0.3	<0.001	0.115	0.002	0.103	<0.001
247	117(f)	63	SW	9.3	0.036	0.5	0.001	0.117	0.012	0.105	<0.001
221	80(f)	64	WNW	2.7	0.006	0.2	<0.001	0.095	0.003	0.085	<0.001
145	28(f), 28(290)(g)	64	NNW	3.2	0.012	0.7	0.007	0.098	0.019	0.088	0.001
178	30(f)	65	NNW	21.5	0.102	0.6	0.002	0.098	0.020	0.088	<0.001
181	35(f)	65	NNE	201.5	0.593	0.7	0.042	0.096	0.014	0.086	0.003
250	120(f)	65	SW	15.8	0.056	0.2	0.001	0.115	0.006	0.103	<0.001

Table 13 Modelled Background Acidic Deposition Rates, Estimated Background Lake Net Potential Acid Input and Data Used to Calculate Background Lake Net Potential Acid Input from Sulphate and Nitrate for the 416 Lakes Included in the Assessment (continued)

Lake Identifier(a)	Lake Name/Original Identifier	Distance [km](b)	Direction(b)	Gross Catchment Area [km^2]	Net Annual Inflow [m^3/s]	Sulphate [mg/L]	Nitrate + Nitrite [mg/L]	Modelled Sulphate Background Deposition [keq/ha/yr](c)	Estimated Background Acid Input from Sulphate [keq/ha/yr](d)	Modelled Nitrate Background Deposition [keq/ha/yr](c)	Estimated Background Acid Input from Nitrate [keq/ha/yr](d)
185	39(f)	66	NE	27.4	0.078	0.6	0.001	0.096	0.010	0.086	<0.001
138	Goodwin	66	WSW	34.6	0.100	1.4	0.013	0.117	0.026	0.105	0.001
249	Behan	67	SW	65.5	0.080	0.2	<0.001	0.117	0.002	0.105	<0.001
176	20(f)	67	N	54.0	0.184	0.8	0.002	0.098	0.017	0.088	<0.001
143	25(f), 25(287)(g)	67	NNW	7.8	0.022	1.6	0.002	0.098	0.030	0.088	<0.001
175	Georges	68	N	155.8	0.543	6.8	0.002	0.098	0.156	0.088	<0.001
117	26(f), A26(g)	68	NNW	11.7	0.037	1.4	0.032	0.098	0.029	0.088	0.002
122	86(f), A86(g)	70	W	4.8	0.012	1.5	0.009	0.095	0.024	0.085	<0.001
183	37(f)	70	NNE	37.0	0.068	0.6	<0.001	0.096	0.007	0.086	<0.001
177	22(f)	70	NNW	18.8	0.067	1.3	0.004	0.098	0.030	0.088	<0.001
179	31(f)	70	NNW	6.4	0.025	1.4	0.279	0.098	0.037	0.088	0.025
116	24(f), A24(g)	70	NNW	8.8	0.034	1.0	<0.001	0.098	0.026	0.088	0.001
218	77(f)	71	WNW	147.3	0.709	0.5	0.014	0.095	0.016	0.085	0.001
146	82(f), 82(342)(g)	71	WNW	6.1	0.014	0.6	0.011	0.095	0.009	0.085	0.001
131	Base	71	W	64.1	0.328	2.2	0.014	0.095	0.072	0.085	0.002
225	85(f)	71	W	6.4	0.021	0.5	<0.001	0.095	0.011	0.085	<0.001
144	27(f), 27(289)(g)	72	NW	7.1	0.022	0.8	0.001	0.098	0.015	0.088	<0.001
220	79(f)	72	WNW	15.6	0.060	0.4	<0.001	0.095	0.011	0.085	<0.001
246	116(f)	73	WSW	11.2	0.037	1.1	0.001	0.117	0.023	0.105	<0.001
38	L8(i)	74	NNW	0.8	0.003	2.3	–	0.098	0.055	0.088	-
115	21(f), A21(g)	74	NNW	14.7	0.087	3.4	0.013	0.098	0.131	0.088	0.002
224	84(f)	75	W	9.3	0.029	0.6	0.002	0.095	0.012	0.085	<0.001
251	Big Chief	76	SW	13.0	0.038	0.9	<0.001	0.117	0.018	0.105	<0.001
36	UNL3(i)	76	N	1.6	0.003	4.7	0.077	0.098	0.067	0.088	0.004
174	17(f)	76	NNW	40.7	0.188	1.3	0.009	0.098	0.040	0.088	0.001
118	29(f), A29(g)	76	NW	5.2	0.017	0.8	0.002	0.095	0.018	0.085	<0.001
37	Surmont	77	NNW	82.4	0.313	2.7	0.167	0.098	0.068	0.088	0.014
259	Logan	77	SSW	244.6	0.931	4.7	0.001	0.115	0.117	0.103	<0.001
219	78(f)	78	WNW	23.3	0.102	0.6	0.047	0.095	0.018	0.085	0.005
182	Formby	78	NNE	51.1	0.132	0.3	0.004	0.096	0.005	0.086	<0.001
258	128(f)	79	SW	12.0	0.041	3.0	0.001	0.115	0.066	0.103	<0.001
27	Pushup	81	N	0.9	0.002	1.1	0.069	0.098	0.015	0.088	0.003
223	83(f)	81	WNW	38.1	0.166	0.5	<0.001	0.095	0.014	0.085	<0.001
110	Birch (f)	82	NNE	73.7	0.126	2.1	0.013	0.096	0.023	0.086	<0.001
34	UNL1(i)	82	N	2.3	0.007	2.1	0.102	0.098	0.040	0.088	0.007
1	Birch (j)	83	N	3.7	0.011	15.3	0.081	0.098	0.300	0.088	0.005
39	L10(i)	83	NNW	1.9	0.004	5.8	0.133	0.098	0.078	0.088	0.006
31	Rat	83	N	20.6	0.062	4.5	0.077	0.098	0.090	0.088	0.005
40	L11(i)	84	NNW	0.5	0.002	2.0	–	0.098	0.045	0.088	–
26	Long (f)	84	N	4.5	0.012	4.5	0.101	0.098	0.079	0.088	0.006
28	Sucker	84	N	5.1	0.013	4.4	0.101	0.098	0.071	0.088	0.006
30	Poison	85	N	0.9	0.001	2.2	0.102	0.098	0.024	0.088	0.004
204	63(f)	85	WNW	40.1	0.165	0.4	0.001	0.095	0.010	0.085	<0.001
41	Maqua	86	NNW	6.1	0.022	1.8	–	0.098	0.043	0.088	–
257	Heart	86	SW	495.1	1.760	3.4	0.001	0.117	0.078	0.105	<0.001
29	Frog	86	N	8.3	0.025	3.2	<0.001	0.098	0.063	0.088	0.007
173	Garson	87	NNE	340.0	0.791	0.7	0.010	0.096	0.010	0.086	0.001
226	88(f)	87	WNW	8.1	0.026	0.5	<0.001	0.095	0.010	0.085	<0.001
202	Mariana	88	WNW	2.4	0.008	3.2	<0.001	0.095	0.065	0.085	<0.001
171	Gipsy	88	NNE	94.8	0.063	0.4	<0.001	0.096	0.002	0.086	<0.001
35	PF12(k), UNL2(i)	88	NNW	3.3	0.009	3.2	0.101	0.098	0.061	0.088	0.007
207	66(f)	89	W	14.6	0.057	1.3	0.003	0.095	0.034	0.085	<0.001
33	Kiskatinaw	89	NNW	30.1	0.090	3.1	0.102	0.098	0.060	0.088	0.007
68	LK8(i)	90	SSE	3.2	0.006	0.9	–	0.112	0.011	0.101	–
515	Unnamed 5(i)	90	S	5.8	0.008	13.0	0.015	0.115	0.113	0.103	<0.001
598	UN-5(i)	90	S	247.6	0.701	0.1	0.003	0.115	0.002	0.103	<0.001
256	Piche	90	SW	555.1	1.981	3.6	<0.001	0.117	0.085	0.105	<0.001
25	Canoe	90	NNW	6.1	0.012	2.2	<0.001	0.098	0.029	0.088	0.005

Table 13 Modelled Background Acidic Deposition Rates, Estimated Background Lake Net Potential Acid Input and Data Used to Calculate Background Lake Net Potential Acid Input from Sulphate and Nitrate for the 416 Lakes Included in the Assessment (continued)

Lake Identifier[a]	Lake Name/Original Identifier	Distance [km][b]	Direction[b]	Gross Catchment Area [km^2]	Net Annual Inflow [m^3/s]	Sulphate [mg/L]	Nitrate + Nitrite [mg/L]	Modelled Sulphate Background Deposition [keq/ha/yr][c]	Estimated Background Acid Input from Sulphate [keq/ha/yr][d]	Modelled Nitrate Background Deposition [keq/ha/yr][c]	Estimated Background Acid Input from Nitrate [keq/ha/yr][d]
203	62[f]	90	WNW	7.1	0.029	2.1	0.002	0.095	0.057	0.085	<0.001
597	UN-2[i]	91	S	237.2	0.672	0.1	0.003	0.115	0.002	0.103	<0.001
253	123[f]	91	SW	7.9	0.027	1.8	<0.001	0.117	0.041	0.105	<0.001
170	Nora	91	N	4.9	0.009	0.2	0.002	0.098	0.002	0.088	<0.001
205	Crow	92	W	66.4	0.286	3.2	0.004	0.095	0.091	0.085	<0.001
463	PF9[k]	93	NNW	1.3	0.004	12.3	0.100	0.098	0.258	0.088	0.007
206	65[f]	93	W	111.4	0.475	3.3	0.004	0.095	0.091	0.085	<0.001
254	124[f]	93	SW	125.0	0.313	0.5	<0.001	0.117	0.009	0.105	<0.001
67	LK7[i]	93	SSE	8.1	0.017	1.2	0.100	0.112	0.016	0.101	0.005
172	Baker	93	NNE	16.5	0.035	0.2	<0.001	0.096	0.003	0.086	<0.001
453	PF11[k]	93	NNW	1.3	0.005	2.5	0.100	0.098	0.058	0.088	0.008
3	Gregoire	93	NNW	231.3	0.666	8.5	0.041	0.098	0.160	0.088	0.003
252	122[f]	93	SW	18.8	0.049	0.8	0.001	0.117	0.013	0.105	<0.001
109	Gordon	94	N	535.3	0.650	2.2	0.001	0.086	0.018	0.077	<0.001
452	PF10[k]	94	NNW	1.1	0.004	5.6	0.200	0.098	0.125	0.088	0.015
599	UN-6[i]	95	S	247.8	0.701	0.1	0.073	0.115	0.002	0.103	0.005
66	LK6[i]	96	SSE	3.8	0.008	1.4	0.100	0.112	0.019	0.101	0.005
461	PF7[k]	96	NNW	1.6	0.006	9.4	0.100	0.098	0.213	0.088	0.008
169	Shortt	96	NNE	169.0	0.294	0.4	0.002	0.096	0.005	0.086	<0.001
65	LK5[i]	97	SSE	17.9	0.036	1.5	<0.001	0.112	0.020	0.101	0.005
32	Caribou Horn	97	N	8.5	0.024	6.7	0.102	0.086	0.123	0.077	0.006
64	LK4[i]	98	SSE	6.6	0.012	1.0	0.100	0.112	0.012	0.101	0.004
60	Burnt	98	S	141.4	0.264	5.3	0.133	0.112	0.065	0.101	0.006
255	125[f]	98	SW	22.0	0.083	3.0	<0.001	0.117	0.074	0.105	<0.001
63	LK3[i]	99	SSE	2.0	0.004	1.0	0.100	0.112	0.013	0.101	0.004
455	PF13[k]	99	N	1.6	0.005	3.9	0.100	0.086	0.080	0.077	0.007
62	LK2[i]	100	SSE	0.8	0.001	1.0	-	0.112	0.010	0.101	-
198	56[f]	101	WNW	20.6	0.081	1.1	<0.001	0.095	0.029	0.085	<0.001
61	LK1[i]	102	SSE	12.1	0.024	1.8	0.100	0.112	0.023	0.101	0.005
536	Touchwood	103	SSW	137.3	0.213	3.7	-	0.115	0.037	0.103	–
208	67[f]	104	W	34.6	0.155	3.6	0.003	0.095	0.106	0.085	<0.001
168	8[f]	105	NNE	22.0	0.073	0.1	0.001	0.087	0.001	0.078	<0.001
516	Sinclair [f]	105	S	56.9	0.094	7.9	<0.001	0.115	0.086	0.103	0.002
199	57[f]	107	WNW	18.1	0.060	3.5	0.001	0.095	0.076	0.085	<0.001
69	May	108	SSE	189.0	0.300	3.6	0.045	0.112	0.038	0.101	0.002
201	60[f]	108	WNW	53.9	0.222	1.4	0.001	0.095	0.038	0.085	<0.001
538	Wolf	109	S	754.7	1.663	2.8	0.001	0.115	0.040	0.103	<0.001
462	PF8[k]	110	NNW	1.6	0.005	19.1	<0.001	0.086	0.371	0.077	0.007
517	Bourque	110	S	100.0	0.149	3.1	0.056	0.115	0.030	0.103	0.002
142	6[f], 6(271)[g]	113	NNE	22.0	0.049	0.3	0.023	0.087	0.005	0.078	0.001
209	Agnes [f]	114	W	43.9	0.175	1.2	0.001	0.103	0.032	0.092	<0.001
196	54[f]	117	NW	5.2	0.016	2.8	0.001	0.095	0.056	0.085	<0.001
530	La Loche	117	NE	1,410.4	1.791	–	–	0.096	–	0.086	–
518	Marguerite	117	S	39.3	0.010	0.7	<0.001	0.115	0.001	0.103	<0.001
519	Marie	118	SSE	478.0	0.665	2.8	0.100	0.112	0.025	0.101	<0.001
459	PF5[k]	120	NNW	0.5	0.001	2.8	0.100	0.088	0.049	0.079	0.006
520	Leming	120	S	44.0	0.059	2.4	0.200	0.112	0.022	0.101	0.006
460	PF6[k]	120	NW	0.7	0.002	2.8	0.100	0.088	0.058	0.079	0.007
195	53[f]	121	NW	17.3	0.062	1.5	0.001	0.095	0.036	0.085	<0.001
540	Pinehurst	122	SSW	186.0	0.278	5.0	–	0.117	0.049	0.105	–
194	Algar	122	NW	63.2	0.177	6.2	<0.001	0.095	0.114	0.085	<0.001
537	La Biche	123	SW	4,279.2	11.154	0.1	–	0.117	0.001	0.105	–
141	4[f], 4(270)[g]	123	N	18.1	0.041	0.3	0.003	0.086	0.004	0.077	<0.001
197	55[f]	124	WNW	18.2	0.061	3.4	0.001	0.095	0.074	0.085	<0.001
600	Dolly	125	SSE	244.3	0.691	5.0	0.550	0.112	0.093	0.101	0.035
521	Tucker	126	S	277.0	0.461	5.3	0.032	0.115	0.058	0.103	0.001
533	McLean	128	NE	235.4	0.327	–	–	0.096	–	0.086	–
522	Ethel	128	S	594.0	0.647	4.0	<0.001	0.112	0.029	0.101	<0.001

Table 13 Modelled Background Acidic Deposition Rates, Estimated Background Lake Net Potential Acid Input and Data Used to Calculate Background Lake Net Potential Acid Input from Sulphate and Nitrate for the 416 Lakes Included in the Assessment (continued)

Lake Identifier(a)	Lake Name/Original Identifier	Distance [km](b)	Direction(b)	Gross Catchment Area [km²]	Net Annual Inflow [m³/s]	Sulphate [mg/L]	Nitrate + Nitrite [mg/L]	Modelled Sulphate Background Deposition [keq/ha/yr](c)	Estimated Background Acid Input from Sulphate [keq/ha/yr](d)	Modelled Nitrate Background Deposition [keq/ha/yr](c)	Estimated Background Acid Input from Nitrate [keq/ha/yr](d)
523	Hilda	129	S	79.8	0.051	15.5	<0.001	0.112	0.066	0.101	<0.001
450	P99(k)	130	NNW	0.5	0.002	2.9	0.100	0.088	0.056	0.079	0.007
546	Cold	131	SSE	6,513.0	18.180	6.5	0.157	0.112	0.120	0.101	0.010
451	PF1(k)	131	NNW	0.6	0.002	4.0	0.100	0.088	0.082	0.079	0.007
456	PF2(k)	131	NNW	0.7	0.002	3.3	0.100	0.088	0.069	0.079	0.007
457	PF3(k)	131	NW	0.7	0.002	3.9	0.100	0.088	0.066	0.079	0.006
211	70(f)	131	W	11.5	0.038	2.3	<0.001	0.103	0.051	0.092	<0.001
458	PF4(k)	131	NNW	0.3	0.001	5.3	0.100	0.088	0.107	0.079	0.007
539	Field	132	SW	12.7	0.033	95.5	–	0.117	1.644	0.105	–
596	Manatokan	135	S	409.3	1.152	8.5	0.220	0.132	0.157	0.109	0.014
210	69(f)	135	W	12.6	0.041	1.2	0.001	0.103	0.025	0.092	<0.001
129	2(f), 15(h), E15(L15b)(g)	137	N	25.0	0.081	0.6	0.006	0.086	0.014	0.077	<0.001
135	3(f), 16(h)	137	NNE	10.9	0.037	1.3	0.013	0.087	0.030	0.078	0.001
121	59(f), A59(g)	137	WNW	44.8	0.174	1.6	0.010	0.103	0.042	0.092	0.001
405	P101(k)	138	NNW	1.1	0.004	3.7	0.100	0.088	0.082	0.079	0.008
212	71(f)	138	W	21.9	0.084	5.2	<0.001	0.103	0.132	0.092	0.006
479	PTH12(k)	140	N	1.2	0.004	2.9	<0.001	0.086	0.065	0.077	0.008
156	P98(k), P98(g)	141	NNW	1.9	0.007	2.2	0.037	0.088	0.051	0.079	0.003
214	73(f)	142	W	24.9	0.092	3.8	0.150	0.103	0.091	0.092	0.012
155	P97(k), P97(g)	142	NNW	1.8	0.006	1.4	0.031	0.088	0.029	0.079	0.002
213	72(f)	142	W	7.7	0.025	11.1	<0.001	0.103	0.238	0.092	<0.001
134	1(f), 25(h), 1(267)(g)	144	NNW	34.5	0.118	0.9	0.006	0.088	0.021	0.079	<0.001
200	58(f)	145	WNW	21.6	0.078	0.8	<0.001	0.103	0.019	0.092	<0.001
154	P96(k), P96(g)	147	NNW	1.3	0.003	1.7	0.029	0.088	0.031	0.079	0.002
416	P30(k)	147	N	1.8	0.006	3.6	<0.001	0.086	0.077	0.077	0.001
478	PTH11(k)	147	N	2.7	0.010	2.5	0.100	0.086	0.059	0.077	0.008
608	Suncor_VS_UW1	149	NNW	5.8	0.017	7.3	0.170	0.086	0.141	0.077	0.011
467	PM4(k)	149	N	17.4	0.066	2.8	0.100	0.086	0.070	0.077	0.009
215	Long (j)	149	W	31.1	0.111	4.5	<0.001	0.103	0.105	0.092	0.005
425	P47(k)	150	N	16.7	0.063	3.2	0.100	0.086	0.079	0.077	0.008
58	Shipyard	151	NNW	42.9	0.130	5.3	0.076	0.086	0.105	0.077	0.005
449	P95(k)	152	NNW	1.6	0.006	5.5	0.100	0.088	0.129	0.079	0.008
424	P46(k)	152	N	1.4	0.005	2.9	0.100	0.086	0.065	0.077	0.008
140	L5(l), P28(k)	154	N	11.8	0.048	2.6	0.051	0.086	0.068	0.077	0.005
84	L8(l), L8(g)	154	N	10.6	0.045	1.4	<0.001	0.086	0.039	0.077	0.001
216	75(f)	156	W	4.1	0.007	5.3	<0.001	0.103	0.058	0.092	<0.001
319	L6(l)	157	N	32.4	0.137	2.5	0.002	0.086	0.070	0.077	<0.001
83	L7(l), L7(g)	159	N	21.5	0.101	3.7	0.008	0.086	0.113	0.077	0.001
217	Pelican	160	W	283.2	0.962	7.1	<0.001	0.103	0.158	0.092	<0.001
190	46(f)	161	WNW	33.7	0.131	0.6	0.001	0.103	0.016	0.092	<0.001
161	49(f), A300(g)	164	WNW	25.0	0.026	0.2	0.002	0.103	0.001	0.092	<0.001
191	48(f)	164	WNW	3.3	0.008	0.5	<0.001	0.103	0.007	0.092	<0.001
329	Mildred	164	NNW	9.1	0.015	42.0	0.139	0.088	0.446	0.079	0.005
422	P44(k)	164	N	2.3	0.009	3.8	0.100	0.086	0.096	0.077	0.009
120	47(f), A47(g)	165	WNW	8.6	0.034	1.4	0.302	0.103	0.036	0.092	0.027
150	P27(k), P27(g)	165	N	4.0	0.017	0.8	0.043	0.086	0.023	0.077	0.004
82	170(f), 14(h), L4(l), A170(L4)(g)	165	N	18.2	0.083	3.8	0.031	0.086	0.116	0.077	0.003
423	P45(k)	166	N	1.3	0.004	8.2	<0.001	0.086	0.163	0.077	0.014
322	L15(l)	166	N	8.0	0.026	16.0	<0.001	0.087	0.340	0.078	0.001
477	PTH10(k)	166	N	8.4	0.028	2.4	0.100	0.086	0.052	0.077	0.007
137	Wood Buffalo	167	WNW	81.4	0.332	5.2	0.013	0.103	0.139	0.092	0.001
535	Turnor	167	NE	2,551.5	3.579	–	–	0.086	–	0.078	–
485	PTH9(k)	167	N	2.6	0.007	3.9	0.100	0.086	0.070	0.077	0.006
314	Sandy (f)	169	W	395.4	1.084	13.4	0.001	0.103	0.241	0.092	<0.001
193	50(f)	170	WNW	38.3	0.148	0.4	<0.001	0.103	0.010	0.092	<0.001
320	L9(l)	170	N	33.4	0.135	2.5	0.002	0.087	0.066	0.078	<0.001
189	45(f)	171	WNW	119.5	0.496	0.7	<0.001	0.103	0.018	0.092	<0.001
119	42(f), A42(g)	172	WNW	25.1	0.088	0.8	0.027	0.103	0.019	0.092	0.002

Table 13 Modelled Background Acidic Deposition Rates, Estimated Background Lake Net Potential Acid Input and Data Used to Calculate Background Lake Net Potential Acid Input from Sulphate and Nitrate for the 416 Lakes Included in the Assessment (continued)

Lake Identifier(a)	Lake Name/Original Identifier	Distance [km](b)	Direction(b)	Gross Catchment Area [km²]	Net Annual Inflow [m³/s]	Sulphate [mg/L]	Nitrate + Nitrite [mg/L]	Modelled Sulphate Background Deposition [keq/ha/yr](c)	Estimated Background Acid Input from Sulphate [keq/ha/yr](d)	Modelled Nitrate Background Deposition [keq/ha/yr](c)	Estimated Background Acid Input from Nitrate [keq/ha/yr](d)
414	P25(k)	172	N	8.6	0.036	1.9	0.100	0.086	0.053	0.077	0.010
445	P9(k)	172	N	4.9	0.020	2.2	<0.001	0.086	0.058	0.077	0.009
188	44(f)	173	WNW	156.9	0.654	0.3	0.002	0.103	0.008	0.092	<0.001
306	Horsetail	173	WNW	124.7	0.393	1.1	0.342	0.103	0.022	0.092	0.024
413	P24(k)	174	N	7.6	0.032	5.3	<0.001	0.086	0.147	0.077	0.009
440	P8(k)	174	N	2.1	0.008	1.7	0.100	0.086	0.044	0.077	0.009
152	P7(k), P7(g)	174	N	1.9	0.007	0.6	0.025	0.086	0.014	0.077	0.002
606	P2	174	NNW	9.5	0.018	4.6	0.100	0.086	0.056	0.077	0.004
432	P6(k)	175	N	4.0	0.016	2.5	0.100	0.086	0.065	0.077	0.009
316	D254(j)	176	NW	390.6	1.484	3.4	0.001	0.092	0.085	0.083	<0.001
421	P43(k)	177	N	3.5	0.014	2.4	0.100	0.086	0.062	0.077	0.009
318	L3(l)	178	N	7.2	0.030	2.5	<0.001	0.086	0.069	0.077	0.001
149	P23(k), P23(g)	178	N	7.3	0.030	1.0	0.026	0.086	0.027	0.077	0.002
466	PM3(k)	178	N	1.0	0.004	1.7	0.100	0.086	0.047	0.077	0.009
465	PM2(k)	178	N	0.7	0.003	1.2	<0.001	0.086	0.033	0.077	0.009
317	L2(l)	179	N	9.8	0.041	2.5	0.010	0.086	0.069	0.077	0.001
56	UW6(i)	179	NNW	9.7	0.017	8.8	0.100	0.088	0.099	0.079	0.004
464	PM1(k)	179	N	0.5	0.002	1.1	<0.001	0.086	0.030	0.077	0.009
55	UW5(i)	179	NNW	12.4	0.023	5.2	0.100	0.086	0.064	0.077	0.004
605	P1	179	NNW	18.3	0.035	5.5	0.100	0.086	0.068	0.077	0.004
52	UW2(i)	179	NNW	36.9	0.070	3.6	0.100	0.088	0.044	0.079	0.004
53	UW3(i)	179	NNW	20.6	0.039	5.9	0.100	0.086	0.073	0.077	0.004
51	UW1(i)	179	NNW	20.5	0.039	5.8	<0.001	0.088	0.072	0.079	0.004
607	P4	180	NNW	6.6	0.012	2.5	0.100	0.086	0.031	0.077	0.004
54	UW4(i)	180	NNW	12.6	0.023	5.0	<0.001	0.086	0.060	0.077	0.004
88	168(f), 12(h), L14(l)	180	N	29.5	0.096	1.7	0.009	0.087	0.037	0.078	0.001
81	L1(l), L1(g)	181	N	4.3	0.016	3.1	0.006	0.086	0.075	0.077	<0.001
532	unnamed	181	NE	21.0	0.107	–	–	0.086	–	0.078	–
87	167(f), L13(l)	181	N	15.7	0.047	1.4	0.044	0.087	0.027	0.078	0.003
447	P91(k)	182	NNW	13.7	0.043	6.7	<0.001	0.088	0.137	0.079	0.007
153	P94(k), P94(g)	182	NNW	0.7	0.002	12.4	0.030	0.088	0.220	0.079	0.002
20	Isadore's	182	NNW	28.0	0.088	54.9	0.067	0.088	1.134	0.079	0.005
446	P90(k)	182	NNW	0.6	0.002	5.2	0.100	0.088	0.084	0.079	0.006
86	166(f), L12(l)	183	N	7.1	0.022	1.5	<0.001	0.087	0.030	0.078	<0.001
4	Kearl	184	N	71.1	0.169	4.9	0.039	0.086	0.077	0.077	0.002
187	41(f)	185	WNW	72.7	0.300	6.9	<0.001	0.103	0.186	0.092	<0.001
420	P4(k)	188	NNW	2.6	0.007	3.8	<0.001	0.086	0.063	0.077	0.006
78	UNL-1(i)	191	N	13.1	0.033	5.0	<0.001	0.086	0.082	0.077	0.006
304	D226(j)	192	WNW	14.5	0.022	50.7	<0.001	0.092	0.496	0.083	<0.001
415	P3(k)	195	N	1.9	0.005	5.3	<0.001	0.086	0.084	0.077	0.005
79	UNL-2(i)	195	N	7.4	0.021	5.0	0.100	0.086	0.093	0.077	0.006
419	P38(k)	195	N	0.3	0.001	1.4	0.100	0.086	0.019	0.077	0.005
321	L11(l)	195	N	19.7	0.059	2.5	0.002	0.087	0.049	0.078	<0.001
284	Big Snuff	196	N	17.3	0.054	0.1	0.008	0.087	0.003	0.078	0.001
302	D223(j)	196	NW	12.0	0.029	16.2	<0.001	0.092	0.261	0.083	<0.001
411	P2(k)	197	N	2.6	0.006	9.2	0.100	0.086	0.146	0.077	0.005
80	P5(k), UNL-3(i)	197	N	3.0	0.007	2.6	0.100	0.086	0.042	0.077	0.006
373	22(h)	200	NW	505.6	1.719	21.0	0.025	0.092	0.469	0.083	0.002
85	164(f), 17(h), L10(l)	201	N	11.4	0.035	1.7	0.009	0.087	0.034	0.078	0.001
534	Proudfoot	202	NE	31.3	0.136	–	–	0.086	–	0.078	–
300	D221(j)	203	NW	7.0	0.001	15.0	0.001	0.092	0.014	0.083	<0.001
19	Calumet	205	NNW	57.5	0.034	41.2	<0.001	0.088	0.158	0.079	0.002
12	LK-7(i)	205	NNW	2.1	0.001	3.8	0.100	0.088	0.013	0.079	0.001
89	Rabbit	206	NW	14.6	0.035	16.5	0.015	0.092	0.258	0.083	0.001
488	PW3(k)	206	NNW	0.7	0.003	6.4	0.100	0.088	0.169	0.079	0.009
5	McClelland	206	N	230.4	0.393	5.5	0.063	0.086	0.062	0.077	0.002
283	163(f)	206	N	10.1	0.024	0.1	0.001	0.079	0.002	0.071	<0.001
18	Lillian	206	NNW	7.4	0.004	3.1	0.125	0.088	0.010	0.079	0.001

Table 13 Modelled Background Acidic Deposition Rates, Estimated Background Lake Net Potential Acid Input and Data Used to Calculate Background Lake Net Potential Acid Input from Sulphate and Nitrate for the 416 Lakes Included in the Assessment (continued)

Lake Identifier(a)	Lake Name/Original Identifier	Distance [km](b)	Direction(b)	Gross Catchment Area [km^2]	Net Annual Inflow [m^3/s]	Sulphate [mg/L]	Nitrate + Nitrite [mg/L]	Modelled Sulphate Background Deposition [keq/ha/yr](c)	Estimated Background Acid Input from Sulphate [keq/ha/yr](d)	Modelled Nitrate Background Deposition [keq/ha/yr](c)	Estimated Background Acid Input from Nitrate [keq/ha/yr](d)
406	P11(k)	207	NNW	2.0	0.008	7.4	<0.001	0.088	0.193	0.079	0.009
336	L51(l)	207	NW	65.9	0.180	5.0	0.001	0.092	0.089	0.083	<0.001
484	PTH8(k)	207	N	0.6	0.002	2.2	0.100	0.079	0.036	0.071	0.006
487	PW2(k)	207	NNW	0.6	0.002	13.3	0.100	0.088	0.326	0.079	0.008
301	D222(j)	207	NW	4.6	0.001	22.4	0.001	0.092	0.032	0.083	<0.001
337	L52(l)	209	NW	11.1	0.034	17.0	0.136	0.092	0.346	0.083	0.009
418	P35(k)	209	N	1.3	0.003	1.8	0.100	0.079	0.027	0.071	0.005
407	P14(k)	210	NNW	8.9	0.034	24.5	<0.001	0.088	0.608	0.079	0.009
282	162(f)	210	N	10.2	0.009	–	0.001	0.079	–	0.071	<0.001
486	PW1(k)	210	NNW	1.8	0.008	23.2	0.200	0.088	0.640	0.079	0.019
483	PTH7(k)	210	N	0.9	0.003	3.5	0.100	0.079	0.062	0.071	0.006
443	P86(k)	210	NNW	3.8	0.015	51.1	0.100	0.088	1.333	0.079	0.009
148	P13(k), P13(g)	211	NNW	3.8	0.012	6.6	0.028	0.088	0.138	0.079	0.002
339	L54(l)	212	NW	236.9	0.915	44.0	0.048	0.092	1.117	0.083	0.004
338	L53(l)	213	NW	50.6	0.180	87.0	0.480	0.092	2.033	0.083	0.038
409	P17(k)	214	NNW	0.5	0.002	31.7	<0.001	0.088	0.761	0.079	0.008
417	P34(k)	214	N	0.9	0.002	2.5	0.100	0.079	0.037	0.071	0.005
6	LK-1(i)	214	NNW	3.8	0.002	87.9	0.100	0.081	0.360	0.072	0.001
408	P16(k)	214	NNW	1.0	0.004	32.6	0.100	0.088	0.923	0.079	0.010
410	P18(k)	215	NNW	0.6	0.002	27.6	0.100	0.088	0.665	0.079	0.008
482	PTH6(k)	215	N	0.9	0.002	3.2	0.100	0.079	0.055	0.071	0.006
281	161(f)	216	N	8.1	0.011	–	0.002	0.079	–	0.071	<0.001
102	33(h), L33(l)	217	NNW	10.2	0.022	18.0	0.014	0.088	0.254	0.079	0.001
526	Preston	218	NNE	252.5	1.204	–	<0.001	0.086	–	0.078	–
481	PTH5(k)	218	N	1.0	0.002	2.8	0.100	0.079	0.044	0.071	0.005
475	PT9(k)	218	NNW	0.6	0.003	4.7	0.100	0.088	0.134	0.079	0.010
278	157(f)	218	N	42.3	0.103	0.2	0.001	0.079	0.003	0.071	<0.001
280	160(f)	218	N	24.4	0.063	0.2	<0.001	0.079	0.004	0.071	<0.001
528	Lloyd	219	NNE	4,250.0	22.599	–	<0.001	0.086	–	0.078	–
103	Audet	220	N	96.5	0.208	2.5	0.009	0.079	0.035	0.071	<0.001
374	Carrot	221	NW	179.8	0.581	8.0	0.025	0.092	0.170	0.083	0.002
104	Johnson	222	N	73.5	0.151	2.3	0.009	0.076	0.031	0.068	<0.001
279	158(f)	222	N	14.5	0.029	–	0.001	0.079	–	0.071	<0.001
299	Chipewyan	222	NW	100.0	0.322	10.3	0.007	0.092	0.217	0.083	0.001
10	LK-5(i)	223	NNW	0.8	0.002	30.4	0.100	0.081	0.531	0.072	0.006
341	L56(l)	224	NW	37.9	0.168	8.0	0.003	0.092	0.232	0.083	<0.001
444	P87(k)	224	NNW	4.1	0.022	3.2	0.100	0.081	0.112	0.072	0.012
442	P85(k)	224	NNW	2.2	0.011	5.6	0.100	0.088	0.195	0.079	0.012
17	LK-12(i)	224	NNW	2.5	0.008	25.4	0.100	0.081	0.520	0.072	0.007
340	L55(l)	225	NW	26.2	0.093	13.0	0.003	0.092	0.302	0.083	<0.001
441	P84(k)	226	NNW	0.9	0.005	3.2	0.100	0.088	0.107	0.079	0.011
11	LK-6(i)	226	NNW	3.8	0.011	26.4	0.100	0.081	0.483	0.072	0.006
474	PT8(k)	226	NNW	0.1	0.000	31.8	0.100	0.081	0.755	0.072	0.008
436	P70(k)	226	NNW	1.7	0.009	2.1	0.100	0.081	0.075	0.072	0.012
7	LK-2(i)	227	NNW	7.3	0.018	1.8	0.100	0.081	0.029	0.072	0.006
430	P52(k)	229	NNW	0.9	0.001	52.7	<0.001	0.081	0.372	0.072	0.002
473	PT6(k)	229	NNW	0.2	<0.001	27.3	<0.001	0.081	0.196	0.072	0.002
91	Namur	230	NNW	224.0	0.325	7.1	0.003	0.092	0.067	0.083	<0.001
426	P48(k)	230	NNW	4.6	0.021	14.7	0.100	0.081	0.446	0.072	0.010
525	Forrest	232	NNE	434.0	2.071	–	–	0.079	–	0.071	–
323	S. Gardiner	232	NNW	1,201.3	3.324	6.0	0.002	0.081	0.109	0.072	<0.001
277	153(f)	232	N	17.4	0.042	–	<0.001	0.079	–	0.071	<0.001
346	Canopener	232	NNW	10.9	0.021	1.5	<0.001	0.081	0.019	0.072	<0.001
345	Buoy	233	NNW	25.2	0.065	6.0	0.017	0.081	0.102	0.072	0.001
524	Patterson	235	NNE	265.0	1.194	–	–	0.079	–	0.071	–
428	P50(k)	235	NNW	2.9	0.015	7.5	0.100	0.081	0.253	0.072	0.012
434	P61(k)	235	NNW	0.8	0.004	2.5	0.200	0.081	0.084	0.072	0.023
429	P51(k)	235	NNW	0.4	0.002	23.7	<0.001	0.081	0.640	0.072	0.009

Table 13 Modelled Background Acidic Deposition Rates, Estimated Background Lake Net Potential Acid Input and Data Used to Calculate Background Lake Net Potential Acid Input from Sulphate and Nitrate for the 416 Lakes Included in the Assessment (continued)

Lake Identifier(a)	Lake Name/Original Identifier	Distance [km](b)	Direction(b)	Gross Catchment Area $[km^2]$	Net Annual Inflow $[m^3/s]$	Sulphate [mg/L]	Nitrate + Nitrite [mg/L]	Modelled Sulphate Background Deposition [keq/ha/yr](c)	Estimated Background Acid Input from Sulphate [keq/ha/yr](d)	Modelled Nitrate Background Deposition [keq/ha/yr](c)	Estimated Background Acid Input from Nitrate [keq/ha/yr](d)
324	N. Gardiner	235	NNW	1,026.5	2.748	6.0	0.002	0.081	0.106	0.072	<0.001
412	P20(k)	236	NNW	0.8	0.004	3.2	0.100	0.081	0.102	0.072	0.011
431	P54(k)	236	NNW	0.4	0.001	10.9	0.100	0.081	0.213	0.072	0.007
472	PT5(k)	236	NNW	1.5	0.008	1.9	0.100	0.081	0.062	0.072	0.011
435	P69(k)	237	NNW	1.0	0.006	1.8	0.100	0.081	0.067	0.072	0.013
438	P77(k)	237	NNW	1.3	0.006	2.7	0.100	0.081	0.090	0.072	0.011
439	P79(k)	237	NNW	2.3	0.012	2.8	0.100	0.081	0.096	0.072	0.012
471	PT4(k)	237	NNW	1.7	0.009	3.0	<0.001	0.081	0.103	0.072	0.012
151	P49(k), P49(g)	237	NNW	0.8	0.004	1.4	0.026	0.081	0.048	0.072	0.003
93	Legend	237	NW	93.1	0.177	2.8	0.011	0.092	0.034	0.083	<0.001
470	PT3(k)	240	NNW	0.6	0.003	3.8	0.100	0.081	0.129	0.072	0.012
527	Beet	241	NNE	456.1	2.408	–	–	0.079	–	0.071	–
325	L21(l)	242	NNW	103.2	0.120	10.0	0.002	0.081	0.076	0.072	<0.001
326	Sand	243	NNW	604.6	1.602	2.5	0.003	0.081	0.044	0.072	<0.001
433	P60(k)	243	NNW	3.5	0.018	4.7	<0.001	0.081	0.163	0.072	0.012
333	L45(l)	244	N	36.1	0.069	2.5	0.001	0.079	0.031	0.071	<0.001
334	L48(l)	244	NNW	102.6	0.278	1.5	<0.001	0.081	0.027	0.072	<0.001
328	Clear	245	NNW	107.2	0.303	2.5	0.010	0.081	0.046	0.072	0.001
468	PT1(k)	246	NNW	1.3	0.005	6.2	0.100	0.081	0.164	0.072	0.009
476	PTH1(k)	247	N	1.0	0.001	5.8	0.100	0.079	0.051	0.071	0.003
437	P72(k)	248	NNW	1.7	0.009	13.6	0.100	0.081	0.436	0.072	0.011
469	PT2(k)	249	NNW	1.0	0.005	12.2	<0.001	0.081	0.375	0.072	0.011
271	145(f)	249	N	18.6	0.026	2.0	0.001	0.079	0.018	0.071	<0.001
108	Waterlily	249	NNW	23.2	0.085	8.8	0.007	0.081	0.212	0.072	0.001
92	Otasan	249	NNW	23.4	0.043	1.4	0.002	0.081	0.017	0.072	<0.001
344	L59(l)	249	NNW	201.4	0.521	4.0	0.004	0.084	0.068	0.076	<0.001
343	L58(l)	250	NW	14.4	0.029	1.5	0.005	0.092	0.020	0.083	<0.001
275	151(f)	250	N	92.0	0.268	1.0	<0.001	0.076	0.018	0.068	<0.001
107	L60(l), L60(g)	251	NNW	60.2	0.163	8.7	0.013	0.084	0.155	0.076	0.001
480	PTH2(k)	251	N	1.2	0.002	4.8	<0.001	0.079	0.055	0.071	0.004
342	L57(l)	251	NW	198.4	0.512	5.0	<0.001	0.092	0.085	0.083	<0.001
327	Eaglenest	251	NNW	128.4	0.307	2.5	0.010	0.081	0.039	0.072	0.001
270	143(f)	251	N	28.3	0.045	1.9	0.001	0.079	0.020	0.071	<0.001
99	144(f), L43(l)	251	N	23.0	0.047	2.2	0.001	0.079	0.029	0.071	<0.001
332	L44(l)	251	N	9.4	0.002	2.5	0.001	0.079	0.003	0.071	<0.001
274	149(f)	251	N	7.1	0.013	0.8	<0.001	0.079	0.010	0.071	<0.001
276	152(f)	252	N	21.9	0.028	0.6	<0.001	0.079	0.005	0.071	<0.001
273	148(f)	253	N	6.2	0.010	0.5	<0.001	0.079	0.005	0.071	<0.001
98	146(f), L40(l)	253	N	5.6	0.002	1.5	0.001	0.079	0.003	0.071	<0.001
330	L41(l)	254	N	36.5	0.046	6.0	0.007	0.079	0.049	0.071	<0.001
105	150(f), 9(h), L39(l), A-150(L39)(g)	256	N	19.2	0.050	2.0	0.005	0.076	0.035	0.068	<0.001
106	Bayard	256	NNW	57.2	0.169	10.3	0.067	0.081	0.200	0.072	0.004
269	142(f)	256	N	36.6	0.087	1.4	<0.001	0.079	0.021	0.071	<0.001
268	141(f)	256	N	42.8	0.078	1.3	<0.001	0.079	0.015	0.071	<0.001
262	Dianne	256	NNW	295.8	0.515	27.7	<0.001	0.081	0.317	0.072	0.004
100	27(h), L47(l), L47(g)	257	NNW	49.2	0.102	9.4	0.098	0.084	0.128	0.076	0.005
335	L50(l)	258	NNW	14.4	0.028	11.0	<0.001	0.084	0.141	0.076	<0.001
267	139(f)	258	N	10.5	0.011	0.8	<0.001	0.079	0.005	0.071	<0.001
265	Pearson	258	N	16.8	0.014	1.3	<0.001	0.079	0.007	0.071	<0.001
331	L42(l)	259	N	49.6	0.074	2.5	0.001	0.079	0.025	0.071	<0.001
272	Poplar	259	N	48.0	0.117	1.1	<0.001	0.079	0.017	0.071	<0.001
266	Kress	259	N	31.0	0.066	0.1	<0.001	0.079	0.001	0.071	<0.001
101	L49(l), L49(g)	260	NNW	31.1	0.067	14.6	0.107	0.084	0.206	0.076	0.005
264	136(f)	260	N	5.2	0.003	0.2	<0.001	0.079	0.001	0.071	<0.001
263	134(f)	262	N	8.2	0.007	-	<0.001	0.081	-	0.072	<0.001
260	131(f)	262	NNW	11.9	0.013	56.0	0.004	0.081	0.388	0.072	<0.001
261	Ronald	263	NNW	346.1	0.564	34.1	0.025	0.081	0.365	0.072	0.001
351	L68(l)	264	NNW	2.1	0.004	6.0	0.005	0.081	0.075	0.072	<0.001

Table 13 Modelled Background Acidic Deposition Rates, Estimated Background Lake Net Potential Acid Input and Data Used to Calculate Background Lake Net Potential Acid Input from Sulphate and Nitrate for the 416 Lakes Included in the Assessment (continued)

Lake Identifier(a)	Lake Name/Original Identifier	Distance [km](b)	Direction(b)	Gross Catchment Area [km^2]	Net Annual Inflow [m^3/s]	Sulphate [mg/L]	Nitrate + Nitrite [mg/L]	Modelled Sulphate Background Deposition [keq/ha/yr](c)	Estimated Background Acid Input from Sulphate [keq/ha/yr](d)	Modelled Nitrate Background Deposition [keq/ha/yr](c)	Estimated Background Acid Input from Nitrate [keq/ha/yr](d)
352	L69(l)	264	NNW	2.4	0.004	10.0	0.003	0.081	0.111	0.072	<0.001
348	Currie	267	N	15.5	0.023	1.5	0.004	0.079	0.014	0.071	<0.001
95	29(h), L27(l)	267	NW	12.6	0.023	4.3	0.018	0.084	0.051	0.076	0.001
350	Harwood	268	N	9.1	0.014	1.5	0.002	0.076	0.015	0.068	<0.001
349	Archer	273	N	42.9	0.087	1.5	0.018	0.076	0.020	0.068	0.001
347	L64(l)	275	N	9.7	0.002	1.5	0.002	0.079	0.002	0.071	<0.001
96	28(h), L28(l), L28(g)	280	NNW	19.0	0.045	2.2	0.023	0.084	0.035	0.076	0.001
97	Clayton	283	NNW	13.1	0.033	0.6	0.002	0.081	0.010	0.072	<0.001
529	Sandy (j)	304	N	452.7	0.624	–	–	0.076	–	0.068	–
531	Cluff	309	NNE	219.0	1.256	–	–	0.079	–	0.071	–

(a) Identifier used on map showing lake locations.

(b) Distance and direction relative to the MEG CLRP.

(c) Estimated deposition rates from the AENV RELAD modelling (Cheng 2001).

(d) Estimated background acid input based on measured nitrate and sulphate concentrations in lakes (Section 5.2).

(e) Identifier used in the Water Quality Baseline Report for this study (Volume 4, Appendix 4-IV).

(f) Identifier used by previous EIAs, refer to Section 5.3.

(g) Identifier used by RAMP (2004).

(h) Identifier used by Erickson (1987).

(i) Identifier used by Saffran and Trew (1996).

(j) Identifier used by Syncrude (2000).

(k) Identifier used by WRS (2004) for one hundred ponds sampled within Oil Sands Region during September 2000.

(l) Identifier used by WRS (2004) for a survey of 34 lakes conducted by Alberta-Pacific Forest Industries in 1999.

– = No data or not applicable.

5.3 CRITICAL LOADS OF ACIDITY

Critical loads of acidity for lakes and data used to calculate critical loads are provided in Table 14. Previously calculated critical loads (referred to as "literature critical loads") are also provided.

In some cases, the critical loads calculated without adjusting for organic acids (Table 14) are different from previously calculated critical loads. This reflects use of all available water quality data to calculate critical loads for this assessment, whereas previously calculated critical loads were often based on water quality data collected during a single sampling event.

Critical loads adjusted for organic acids are typically lower than those calculated without inclusion of organic acids. For lakes with lower ANC values, the difference between the two calculations becomes more pronounced; for lakes with higher ANC values, the two calculations provide similar results. Lakes lacking DOC and pH data were always in the higher ANC range; therefore, critical loads calculated using the two methods would likely be similar.

Table 14 Critical Loads of Acidity for the 416 Lakes Included in the Assessment

Lake Identifier(a)	Lake Name/ Original Identifier	Distance [km](b)	Direction(b)	Gross Catchment Area $[km^2]$	Net Annual Inflow $[m^3/s]$	Calcium [mg/L]	Magnesium [mg/L]	Sodium [mg/L]	Potassium [mg/L]	DOC [mg/L]	pH	Alkalinity [μeq/L]	ANC_{org} [μeq/L]	SA_{org} [μeq/L]	Critical Load With Organic Acids [keq/ha/yr]	Critical Load Without Organic Acids [keq/ha/yr]	Literature Critical Load [keq/ha/yr]	Literature Critical Load/Gross Catchment Area/Net Annual Inflow Data Source
618	Unnamed WB 9-04(c)	2	W	2.1	0.004	17	6.0	2.7	0.5	8	7.9	1,227	60	72	0.924	0.933	-	-
617	Unnamed WB 7-04(c)	3	WNW	2.2	0.005	8	4.3	1.7	0.5	30	7.6	640	166	201	0.494	0.517	-	-
616	Unnamed WB 8-04(c)	3	W	2.4	0.005	18	6.3	3.0	0.4	9	8.0	1,367	69	75	0.978	0.982	-	-
620	Unnamed WB 11-04(c)	4	E	8.7	0.018	14	5.0	1.2	0.5	9	8.0	1,027	73	78	0.722	0.725	-	-
609	Unnamed WB 2-07(c)	5	NE	1.8	0.004	18	6.7	3.7	1.7	25	8.1	1,493	214	174	1.066	1.040	-	-
614	Unnamed WB 15-04(c)	5	WSW	0.7	0.001	20	7.0	2.5	0.2	11	8.0	1,510	89	88	1.049	1.049	-	-
231	95(d), Unnamed WB 6-04(c)	7	N	16.1	0.059	8	2.5	1.8	0.7	20	7.6	562	116	143	0.697	0.728	0.852	OPTI/RAMP (OPTI Canada Inc 2000)
615	Unnamed WB 5-04(c)	8	NNW	5.6	0.012	8	2.3	0.8	0.5	9	7.6	493	48	75	0.356	0.374	-	-
610	Unnamed WB 3-07(c)	8	W	15.7	0.033	9	2.7	2.0	0.8	19	7.8	660	121	134	0.443	0.451	-	-
621	Unnamed WB 13-04(c)	9	SE	12.3	0.026	25	8.3	3.3	0.8	11	8.8	1,960	177	89	1.406	1.348	-	-
2	Christina	9	SW	1,233.5	2.809	25	7.5	6.3	1.0	14	7.9	2,077	106	108	1.501	1.502	1.512	Jackpine Mine (Shell 2002)
612	Unnamed WB 2-04(c)	9	W	2.1	0.004	11	3.7	2.3	0.8	15	7.8	867	98	110	0.585	0.593	-	-
613	Unnamed WB 16-04(c)	10	WNW	6.6	0.014	11	3.0	0.8	0.6	10	7.5	620	47	79	0.470	0.491	-	-
611	Unnamed WB 4-07(c)	10	ENE	6.0	0.013	11	3.3	1.4	0.6	18	7.8	800	124	130	0.551	0.555	-	-
147	94(d), 94(354)(e),Unnamed WB 1-07(c)	10	NNW	8.5	0.016	6	1.7	1.3	1.1	22	7.3	371	96	156	0.223	0.260	0.319	WRS 2004
232	97(d), Unnamed WB 12-04(c)	11	E	51.5	0.201	12	3.9	1.4	0.4	16	7.8	854	106	118	1.093	1.107	1.306	WRS 2004
233	98(d)	16	WSW	25.8	0.092	14	4.5	3.5	0.8	21	7.8	998	136	147	1.307	1.320	1.320	WRS 2004
241	108(d)	21	SSW	51.1	0.171	28	8.5	3.3	0.7	11	8.2	2,025	107	89	2.318	2.299	2.297	WRS 2004
240	Kirby	22	S	22.4	0.061	32	10.1	3.6	1.1	7	8.6	2,470	88	62	2.225	2.203	2.200	WRS 2004
237	Winefred, WB-WL(c)	23	SE	1,185.9	4.087	27	7.0	3.5	0.9	10	8.4	2,070	109	82	2.202	2.172	2.305	WRS 2004
230	93(d)	24	NE	11.3	0.039	15	5.9	2.1	0.5	18	7.9	1,168	129	129	1.387	1.387	1.389	WRS 2004
227	Bohn	28	N	200.8	0.565	26	7.6	8.4	1.4	22	8.7	2,018	337	154	2.160	1.997	1.996	WRS 2004
235	101(d)	31	E	6.5	0.021	20	7.5	1.4	0.4	19	8.3	1,466	200	138	1.696	1.633	1.629	WRS 2004
234	100(d)	31	ENE	49.6	0.205	22	7.3	5.0	0.7	26	8.1	1,640	220	175	2.469	2.411	2.404	WRS 2004
229	Cowper	31	NNE	280.5	0.912	19	5.9	6.1	0.9	17	9.1	1,489	353	125	1.917	1.684	1.683	WRS 2004
228	90(d)	31	NNE	19.9	0.062	21	5.5	10.2	1.6	25	8.0	1,613	205	172	1.868	1.837	1.835	WRS 2004
238	104(d)	34	SE	8.7	0.029	21	6.4	2.8	1.1	20	9.0	1,535	376	144	1.988	1.744	1.743	WRS 2004
132	Grist	35	SSE	118.2	0.433	30	8.5	4.0	0.9	7	8.5	2,344	87	65	2.713	2.688	2.798	WRS 2004
239	106(d)	36	SSE	3.5	0.006	30	8.8	2.0	1.8	10	8.3	2,168	100	79	1.170	1.159	1.154	OPTI/RAMP (OPTI Canada Inc 2000)
139	91(d), 7(f)	39	NNE	315.9	1.009	18	5.9	7.0	0.9	16	9.2	1,587	371	120	1.874	1.621	1.620	WRS 2004
186	40(d)	40	N	27.8	0.095	24	7.7	15.7	1.5	27	8.1	2,082	241	183	2.716	2.654	2.652	WRS 2004
244	113(d)	40	SW	35.1	0.148	17	6.4	1.6	0.5	14	8.0	1,279	110	104	1.864	1.856	1.849	WRS 2004
46	UNL4(g)	40	SSW	0.9	0.002	22	8.5	2.0	0.5	19	7.9	1,787	140	134	0.979	0.976	-	WRS 2004
44	UNL1(g)	41	SW	72.0	0.254	18	6.4	2.3	0.6	14	8.0	1,400	113	104	1.665	1.654	-	WRS 2004
236	102(d)	41	E	16.1	0.061	13	4.4	1.3	0.3	10	7.9	973	69	79	1.196	1.207	1.209	WRS 2004
45	UNL3(g)	42	SSW	3.7	0.014	10	3.7	1.0	0.4	18	7.3	760	79	132	0.848	0.910	-	WRS 2004
50	UNL13(g)	42	SW	2.0	0.008	4	1.5	<0.1	0.4	24	6.5	253	52	164	0.199	0.331	-	Kirby (Rio Alta 2002)
49	UNL12(g)	42	SW	1.8	0.007	11	4.3	0.5	0.4	15	7.4	920	70	112	0.960	1.008	-	WRS 2004
48	UNL7(g)	44	SW	1.5	0.005	11	4.4	1.3	0.6	24	7.4	850	114	168	0.827	0.879	-	WRS 2004
47	UNL5(g)	44	SSW	5.1	0.017	13	4.9	1.0	0.6	15	7.7	1,033	89	112	1.110	1.134	-	WRS 2004
43	Ipiatik	46	SSW	56.0	0.182	17	5.4	1.5	0.4	14	7.5	1,340	69	103	1.293	1.327	-	Kearl (Imperial 2005)
42	Wiau	47	SW	339.0	1.117	23	7.4	2.8	0.7	16	8.2	1,770	152	119	1.922	1.888	1.914	WRS 2004
243	111(d)	49	WSW	24.6	0.091	14	2.7	2.4	0.4	19	7.7	1,039	109	134	1.121	1.150	1.375	OPTI/RAMP (OPTI Canada Inc. 2000)
222	81(d)	55	NW	40.0	0.187	10	2.7	1.5	0.6	15	7.6	624	80	109	1.001	1.045	1.041	WRS 2004
167	Wappau	57	WSW	75.9	0.190	28	7.4	3.5	1.2	10	9.1	1,994	205	83	1.758	1.661	1.644	WRS 2004
242	110(d)	58	WSW	11.7	0.040	11	4.0	1.3	0.7	10	8.3	847	101	79	0.976	0.952	0.948	OPTI/RAMP (OPTI Canada Inc. 2000)
245	114(d)	59	WSW	7.2	0.024	8	3.7	1.6	0.7	17	7.6	605	94	123	0.706	0.736	0.737	WRS 2004
180	33(d)	60	NNW	14.2	0.067	3	1.3	0.9	0.3	18	6.6	148	42	129	0.197	0.327	0.331	WRS 2004
184	Watchusk	61	NNE	301.8	0.883	25	6.5	7.5	1.1	20	8.6	1,795	273	139	2.021	1.897	1.896	WRS 2004
130	32(d), 2(f)	62	NNW	30.4	0.128	15	3.4	1.6	0.5	14	7.7	1,101	83	107	1.370	1.402	1.433	WRS 2004
136	34(d), 1(f)	63	NW	73.8	0.301	14	3.6	2.1	0.6	24	7.5	1,023	124	163	1.290	1.341	0.896	WRS 2004
248	Clyde	63	SW	470.3	0.488	22	6.8	2.5	1.0	16	8.1	1,570	132	115	0.566	0.560	0.559	WRS 2004
247	117(d)	63	SW	9.3	0.036	13	7.4	1.9	1.3	22	7.8	1,147	147	154	1.584	1.593	1.594	OPTI/RAMP (OPTI Canada Inc. 2000)
221	80(d)	64	WNW	2.7	0.006	6	2.1	1.2	0.6	19	7.3	405	82	138	0.284	0.322	0.325	WRS 2004
145	28(d), 28(290)(e)	64	NNW	3.2	0.012	2	0.8	0.6	0.4	20	5.9	83	25	144	0.016	0.159	0.130	WRS 2004
178	30(d)	65	NNW	21.5	0.102	1	0.3	0.3	0.3	12	5.2	41	8	91	-0.095	0.030	0.036	WRS 2004
181	35(d)	65	NNE	201.5	0.593	29	7.2	8.5	1.3	21	7.9	2,044	150	145	2.201	2.197	2.195	WRS 2004
250	120(d)	65	SW	15.8	0.056	17	6.8	2.1	0.5	17	8.7	1,329	241	122	1.738	1.605	1.604	OPTI/RAMP (OPTI Canada Inc. 2000)

Table 14 Critical Loads of Acidity for the 416 Lakes Included in the Assessment (continued)

Lake Identifier(a)	Lake Name/ Original Identifier	Distance [km](b)	Direction(b)	Gross Catchment Area [km^2]	Net Annual Inflow [m^3/s]	Calcium [mg/L]	Magnesium [mg/L]	Sodium [mg/L]	Potassium [mg/L]	DOC [mg/L]	pH	Alkalinity [μeq/L]	ANC_{org} [μeq/L]	SA_{org} [μeq/L]	Critical Load With Organic Acids [keq/ha/yr]	Critical Load Without Organic Acids [keq/ha/yr]	Literature Critical Load [keq/ha/yr]	Literature Critical Load/Gross Catchment Area/Net Annual Inflow Data Source
185	39(d)	66	NE	27.4	0.078	17	5.8	5.9	0.5	20	7.9	1,381	139	139	1.389	1.390	1.389	WRS 2004
138	Goodwin	66	WSW	34.6	0.100	12	4.3	0.8	0.9	9	7.7	996	54	76	0.811	0.831	0.937	WRS 2004
249	Behan	67	SW	65.5	0.080	15	5.8	1.9	1.1	15	8.2	1,161	138	112	0.493	0.483	1.192	WRS 2004
176	20(d)	67	N	54.0	0.184	22	6.4	14.7	0.5	24	7.9	1,926	175	169	2.370	2.363	2.358	WRS 2004
143	25(d), 25(287)(e)	67	NNW	7.8	0.022	1	0.3	0.6	0.4	16	5.2	37	10	117	-0.054	0.042	0.031	WRS 2004
175	Georges	68	N	155.8	0.543	42	11.5	9.6	1.6	12	8.4	3,096	143	95	3.815	3.762	3.755	WRS 2004
117	26(d), A26(e)	68	NNW	11.7	0.037	2	0.5	0.6	0.5	11	5.6	65	11	90	0.009	0.088	0.048	WRS 2004
122	86(d), A86(e)	70	W	4.8	0.012	2	0.9	0.8	1.6	14	6.6	141	32	105	0.084	0.140	0.124	WRS 2004
183	37(d)	70	NNE	37.0	0.068	31	10.9	9.6	2.8	13	8.5	2,683	168	102	1.678	1.640	1.637	WRS 2004
177	22(d)	70	NNW	18.8	0.067	3	1.0	0.4	0.4	7	6.9	210	22	65	0.190	0.238	0.237	WRS 2004
179	31(d)	70	NNW	6.4	0.025	1	0.3	0.3	0.3	14	5.6	54	13	104	-0.060	0.053	0.058	WRS 2004
116	24(d), A24(e)	70	NNW	8.8	0.034	1	0.3	0.7	0.4	18	4.7	19	8	132	-0.103	0.046	0.030	WRS 2004
218	77(d)	71	WNW	147.3	0.709	11	2.7	1.6	0.5	23	7.1	614	84	159	1.050	1.164	1.159	WRS 2004
146	82(d), 82(342)(e)	71	WNW	6.1	0.014	3	1.4	1.5	1.1	24	6.8	215	65	163	0.127	0.198	0.164	WRS 2004
131	Base	71	W	64.1	0.328	17	4.9	1.9	0.8	11	7.6	1,248	65	89	2.018	2.056	2.110	WRS 2004
225	85(d)	71	W	6.4	0.021	4	1.3	0.7	1.2	11	7.2	275	41	87	0.233	0.280	0.276	WRS 2004
144	27(d), 27(289)(e)	72	NW	7.1	0.022	2	0.6	0.6	0.4	12	6.5	106	24	93	0.033	0.100	0.112	WRS 2004
220	79(d)	72	WNW	15.6	0.060	10	2.4	1.7	0.6	16	7.5	635	83	115	0.836	0.876	0.877	WRS 2004
246	116(d)	73	WSW	11.2	0.037	8	3.5	0.9	1.5	11	7.7	644	65	87	0.686	0.708	0.708	WRS 2004
38	L8(g)	74	NNW	0.8	0.003	10	2.5	<0.1	0.6	23	6.8	553	62	160	0.614	0.727	0.539	WRS 2004
115	21(d), A21(e)	74	NNW	14.7	0.087	2	0.4	0.8	0.4	17	5.0	32	9	126	-0.068	0.149	0.117	WRS 2004
224	84(d)	75	W	9.3	0.029	4	1.3	0.8	0.9	11	7.1	267	40	89	0.237	0.285	0.287	WRS 2004
251	Big Chief	76	SW	13.0	0.038	15	4.8	1.7	2.4	18	7.9	1,076	129	129	1.121	1.121	1.118	WRS 2004
36	UNL3(g)	76	N	1.6	0.003	25	6.8	11.0	2.3	35	7.8	2,085	231	234	1.568	1.570	1.483	WRS 2004
174	17(d)	76	NNW	40.7	0.188	9	2.3	1.3	0.5	12	7.4	553	53	93	0.866	0.924	0.917	WRS 2004
118	29(d), A29(e)	76	NW	5.2	0.017	1	0.5	0.9	0.3	13	5.8	60	14	97	-0.005	0.082	0.061	WRS 2004
37	Surmont	77	NNW	82.4	0.313	10	2.5	0.3	0.6	16	7.0	593	54	120	0.702	0.782	0.691	Horizon (Canadian Natural 2002)
259	Logan	77	SSW	244.6	0.931	33	12.0	14.1	1.7	16	9.2	2,939	378	118	4.197	3.885	3.879	WRS 2004
219	78(d)	78	WNW	23.3	0.102	13	2.7	1.1	0.3	13	7.3	815	54	97	1.142	1.201	1.201	WRS 2004
182	Formby	78	NNE	51.1	0.132	27	6.8	8.4	0.7	13	8.1	1,935	118	102	1.825	1.812	1.808	WRS 2004
258	128(d)	79	SW	12.0	0.041	39	17.0	5.9	2.8	21	8.5	3,241	261	145	4.001	3.876	3.870	WRS 2004
27	Pushup	81	N	0.9	0.002	10	2.4	1.9	2.4	20	7.8	780	127	139	0.471	0.479	0.479	WRS 2004
223	83(d)	81	WNW	38.1	0.166	16	2.5	0.8	0.7	10	7.9	918	76	83	1.344	1.354	1.355	WRS 2004
110	Birch (d)	82	NNE	73.7	0.126	17	11.3	25.5	1.8	26	8.8	2,863	416	179	1.680	1.552	1.775	WRS 2004
34	UNL1(g)	82	N	2.3	0.007	3	0.8	0.1	1.3	21	6.1	180	30	146	0.044	0.152	0.178	WRS 2004
1	Birch (h)	83	N	3.7	0.011	14	10.5	7.8	2.4	24	7.7	1,921	144	163	1.779	1.797	0.920	Jackpine Mine (Shell 2002)
39	L10(g)	83	NNW	1.9	0.004	2	0.7	<0.1	0.3	10	5.8	160	11	80	0.019	0.064	0.077	Horizon (Canadian Natural 2002)
31	Rat	83	N	20.6	0.062	26	7.8	6.9	1.3	18	7.8	2,075	117	127	2.103	2.112	2.023	WRS 2004
40	L11(g)	84	NNW	0.5	0.002	3	1.0	<0.1	0.3	17	6.0	153	22	124	0.084	0.195	0.202	Horizon (Canadian Natural 2002)
26	Long (d)	84	N	4.5	0.012	9	2.6	3.6	1.1	23	7.2	678	94	160	0.617	0.673	0.672	WRS 2004
28	Sucker	84	N	5.1	0.013	26	7.8	10.4	1.6	19	7.8	2,232	132	136	1.818	1.822	1.745	WRS 2004
30	Poison	85	N	0.9	0.001	23	6.2	8.1	1.2	25	7.8	1,815	160	169	1.022	1.027	0.893	Kearl (Imperial 2005)
204	63(d)	85	WNW	40.1	0.165	10	2.3	2.0	0.5	13	7.5	580	62	97	0.875	0.920	0.914	WRS 2004
41	Maqua	86	NNW	6.1	0.022	8	2.3	0.2	0.5	12	6.9	540	39	96	0.555	0.621	0.450	Fort Hills (True North Energy 2001)
257	Heart	86	SW	495.1	1.760	32	13.9	16.9	2.4	15	8.9	3,136	258	109	4.064	3.898	3.893	OPTI/RAMP (OPTI Canada Inc 2000)
29	Frog	86	N	8.3	0.025	24	7.1	8.6	1.1	29	7.7	1,815	171	193	1.980	2.001	1.826	OPTI/RAMP
173	Garson	87	NNE	340.0	0.791	23	6.5	7.6	0.9	19	8.1	1,733	159	137	1.456	1.439	1.438	WRS 2004
226	88(d)	87	WNW	8.1	0.026	16	4.7	4.1	0.7	11	8.0	1,008	82	86	1.352	1.356	1.348	WRS 2004
202	Mariana	88	WNW	2.4	0.008	9	2.6	15.4	1.2	11	7.2	384	41	86	1.214	1.257	1.269	WRS 2004
171	Gipsy	88	NNE	94.8	0.063	27	13.3	11.9	3.1	5	8.5	2,904	66	53	0.629	0.626	0.625	WRS 2004
35	PF12(i), UNL2(g)	88	NNW	3.3	0.009	9	<0.1	2.1	1.0	26	6.2	203	43	176	0.477	0.598	0.281	WRS 2004
207	66(d)	89	W	14.6	0.057	28	5.6	1.1	0.9	11	8.1	1,703	90	85	2.245	2.239	2.236	WRS 2004
33	Kiskatinaw	89	NNW	30.1	0.090	24	7.4	6.6	0.8	24	7.8	1,935	163	166	1.927	1.930	1.891	WRS 2004
68	LK8(g)	90	SSE	3.2	0.006	13	4.9	1.5	0.4	23	7.8	970	154	160	0.645	0.649	0.649	WRS 2004
515	Unnamed 5(g)	90	S	5.8	0.008	97	52.1	48.1	2.6	48	7.7	8,580	299	311	4.661	4.667	4.667	WRS 2004
598	UN-5(g)	90	S	247.6	0.701	7	2.3	<0.1	<0.1	28	7.2	564	113	193	0.343	0.415	0.414	Kirby (Rio Alta 2002)
256	Piche	90	SW	555.1	1.981	36	14.7	16.5	2.7	12	8.7	3,208	171	92	4.273	4.184	4.179	OPTI/RAMP (OPTI Canada Inc. 2000)
25	Canoe	90	NNW	6.1	0.012	10	3.2	4.3	0.9	20	7.1	800	75	144	0.517	0.559	0.533	WRS 2004
203	62(d)	90	WNW	7.1	0.029	7	2.1	4.7	0.6	15	6.9	272	45	109	0.742	0.825	0.824	WRS 2004

Table 14 Critical Loads of Acidity for the 416 Lakes Included in the Assessment (continued)

Lake Identifier$^{(a)}$	Lake Name/ Original Identifier	Distance [km]$^{(b)}$	Direction$^{(b)}$	Gross Catchment Area [km^2]	Net Annual Inflow [m^3/s]	Calcium [mg/L]	Magnesium [mg/L]	Sodium [mg/L]	Potassium [mg/L]	DOC [mg/L]	pH	Alkalinity [µeq/L]	ANC$_{org}$ [µeq/L]	SA$_{org}$ [µeq/L]	Critical Load With Organic Acids [keq/ha/yr]	Critical Load Without Organic Acids [keq/ha/yr]	Literature Critical Load [keq/ha/yr]	Literature Critical Load/Gross Catchment Area/Net Annual Inflow Data Source
597	UN-2$^{(g)}$	91	S	237.2	0.672	29	8.7	10.2	1.0	21	7.9	3,240	148	148	2.278	2.278	2.301	Primrose East (CNRL 2006)
253	123$^{(d)}$	91	SW	7.9	0.027	30	15.2	7.7	4.8	8	8.7	2,959	120	71	3.408	3.357	3.354	WRS 2004
170	Nora	91	N	4.9	0.009	17	9.2	3.3	1.1	21	9.1	1,589	455	151	1.110	0.942	0.937	WRS 2004
205	Crow	92	W	66.4	0.286	30	7.1	3.7	1.0	12	8.8	1,953	194	94	3.107	2.971	2.967	WRS 2004
463	PF9$^{(i)}$	93	NNW	1.3	0.004	12	4.3	3.0	0.5	26	7.1	640	94	178	0.927	1.012	1.018	WRS 2004
206	65$^{(d)}$	93	W	111.4	0.475	30	7.1	5.1	1.0	14	8.5	1,942	176	106	3.145	3.051	3.048	WRS 2004
254	124$^{(d)}$	93	SW	125.0	0.313	26	8.0	7.9	2.1	16	9.5	2,129	486	119	2.099	1.810	1.808	OPTI/RAMP (OPTI Canada Inc. 2000)
67	LK7$^{(g)}$	93	SSE	8.1	0.017	26	8.1	2.0	0.6	16	8.1	1,953	139	118	1.311	1.297	1.297	WRS 2004
172	Baker	93	NNE	16.5	0.035	30	13.4	6.2	2.5	17	8.7	2,666	249	122	2.015	1.929	1.929	WRS 2004
453	PF11$^{(i)}$	93	NNW	1.3	0.005	5	2.0	<0.1	0.7	32	6.1	200	48	215	0.236	0.424	0.444	WRS 2004
3	Gregoire	93	NNW	231.3	0.666	17	4.6	3.0	0.9	13	7.4	1,108	64	100	1.130	1.162	1.053	Muskeg River Mine Expansion (Shell 2005)
252	122$^{(d)}$	93	SW	18.8	0.049	12	4.2	1.4	3.1	12	7.9	940	90	96	0.822	0.827	0.827	OPTI/RAMP (OPTI Canada Inc. 2000)
109	Gordon	94	N	535.3	0.650	24	10.0	21.1	1.8	21	8.4	2,811	228	147	1.145	1.114	1.112	WRS 2004
452	PF10$^{(i)}$	94	NNW	1.1	0.004	9	2.6	<0.1	1.3	22	6.9	440	66	154	0.556	0.650	0.667	WRS 2004
599	UN-6$^{(g)}$	95	S	247.8	0.701	8	3.4	0.7	8.1	26	6.8	810	74	180	0.653	0.748	0.722	Primrose East (CNRL 2006)
66	LK6$^{(g)}$	96	SSE	3.8	0.008	26	8.0	3.3	0.5	23	8.1	1,953	200	160	1.330	1.305	1.305	WRS 2004
461	PF7$^{(i)}$	96	NNW	1.6	0.006	21	9.5	8.0	0.5	25	7.5	1,660	128	172	2.240	2.288	2.272	WRS 2004
169	Shortt	96	NNE	169.0	0.294	33	9.9	7.7	1.8	16	7.9	2,652	116	115	1.515	1.514	1.513	WRS 2004
65	LK5$^{(g)}$	97	SSE	17.9	0.036	14	4.9	2.0	0.6	18	7.8	1,040	122	128	0.709	0.713	0.713	Primrose East (CNRL 2006)
32	Caribou Horn	97	N	8.5	0.024	23	7.6	5.6	0.8	19	7.7	1,730	119	136	1.721	1.737	1.680	WRS 2004
64	LK4$^{(g)}$	98	SSE	6.6	0.012	18	6.3	2.0	0.5	24	7.9	1,300	175	166	0.852	0.847	0.847	WRS 2004
60	Burnt	98	S	141.4	0.264	28	40.5	3.3	0.7	17	8.1	2,165	148	124	2.852	2.838	2.838	WRS 2004
255	125$^{(d)}$	98	SW	22.0	0.083	35	11.3	13.3	3.0	23	8.5	2,863	291	158	4.047	3.889	3.884	Meadow Creek Project (Petro Canada 2001)
63	LK3$^{(g)}$	99	SSE	2.0	0.004	16	6.4	2.3	0.7	24	7.9	1,220	180	166	0.856	0.847	0.847	WRS 2004
455	PF13$^{(i)}$	99	N	1.6	0.005	25	8.1	5.0	0.4	17	7.7	1,980	104	124	2.042	2.062	2.058	WRS 2004
62	LK2$^{(g)}$	100	SSE	0.8	0.001	13	6.1	2.0	0.7	30	7.8	1,050	197	200	0.574	0.575	0.575	WRS 2004
198	56$^{(d)}$	101	WNW	20.6	0.081	6	1.4	8.0	0.3	33	7.1	455	121	218	0.747	0.866	0.868	WRS 2004
61	LK1$^{(g)}$	102	SSE	12.1	0.024	30	10.1	4.0	1.3	25	8.2	2,340	238	172	1.611	1.569	1.569	WRS 2004
536	Touchwood	103	SSW	137.3	0.213	31	12.2	7.9	2.6	11	8.3	2,826	114	87	1.435	1.422	1.421	Primrose East (CNRL 2006)
208	67$^{(d)}$	104	W	34.6	0.155	11	2.7	1.4	0.7	19	7.3	587	78	134	1.015	1.094	1.097	WRS 2004
168	8$^{(d)}$	105	NNE	22.0	0.073	19	17.5	5.5	1.6	18	8.9	2,466	307	130	2.913	2.727	2.725	WRS 2004
516	Sinclair $^{(d)}$	105	S	56.9	0.094	36	24.2	29.6	2.9	15	8.3	4,860	153	114	2.683	2.663	1.643	WRS 2004
199	57$^{(d)}$	107	WNW	18.1	0.060	7	1.4	3.9	0.2	27	7.0	334	90	184	0.490	0.588	0.584	WRS 2004
69	May	108	SSE	189.0	0.300	32	10.9	5.9	1.2	7	8.1	2,793	58	62	1.363	1.365	1.374	WRS 2004
201	60$^{(d)}$	108	WNW	53.9	0.222	12	2.7	3.7	1.1	27	7.5	688	138	184	1.131	1.191	1.191	WRS 2004
538	Wolf	109	S	754.7	1.663	29	15.9	11.4	2.1	13	8.0	3,150	107	102	2.238	2.235	2.260	Primrose East (CNRL 2006)
462	PF8$^{(i)}$	110	NNW	1.6	0.005	14	5.2	20.0	3.0	29	7.4	1,340	136	196	1.790	1.846	1.853	WRS 2004
517	Bourque	110	S	100.0	0.149	33	18.7	11.1	2.5	7	8.2	3,725	64	61	1.715	1.714	1.750	WRS 2004
142	6$^{(d)}$, 6(271)$^{(e)}$	113	NNE	22.0	0.049	17	5.7	5.8	0.9	30	9.0	1,399	599	203	1.315	1.040	0.887	WRS 2004
209	Agnes $^{(d)}$	114	W	43.9	0.175	6	1.2	0.8	0.8	28	6.5	182	61	189	0.292	0.453	0.451	WRS 2004
196	54$^{(d)}$	117	NW	5.2	0.016	6	1.5	7.7	0.2	28	7.2	410	110	191	0.556	0.633	0.630	WRS 2004
530	La Loche	117	NE	1,410.4	1.791	26	9.3	7.8	1.0	9	8.1	2,375	76	77	0.941	0.941	0.941	Kirby (Rio Alta 2002)
518	Marguerite	117	S	39.3	0.010	17	124.0	55.2	45.9	95	8.8	13,580	1,508	596	1.178	1.108	0.241	WRS 2004
519	Marie	118	SSE	478.0	0.665	26	13.1	5.8	2.2	8	8.1	2,813	69	68	1.155	1.155	1.102	Kirby (Rio Alta 2002)
459	PF5$^{(i)}$	120	NNW	0.5	0.001	34	6.7	1.0	0.8	11	7.9	2,220	80	88	1.852	1.858	1.861	WRS 2004
520	Leming	120	S	44.0	0.059	19	13.8	8.6	5.5	35	8.2	2,362	320	231	1.117	1.079	1.076	WRS 2004
460	PF6$^{(i)}$	120	NW	0.7	0.002	29	5.2	<0.1	0.4	24	7.7	1,780	147	166	1.798	1.818	1.867	Meadow Creek Project (Petro Canada 2001)
195	53$^{(d)}$	121	NW	17.3	0.062	5	1.3	7.6	0.8	26	7.2	430	100	181	0.608	0.700	0.695	WRS 2004
540	Pinehurst	122	SSW	186.0	0.278	32	12.9	8.4	3.8	13	8.5	2,970	164	100	1.458	1.428	1.429	Primrose East (CNRL 2006)
194	Algar	122	NW	63.2	0.177	5	1.3	7.8	0.6	18	7.5	439	88	128	0.529	0.564	0.567	WRS 2004
537	La Biche	123	SW	4,279.2	11.154	29	9.0	11.0	2.3	-	8.6	2,660	-	-	-	2.181	2.298	Primrose East (CNRL 2006)
141	4$^{(d)}$, 4(270)$^{(e)}$	123	N	18.1	0.041	21	7.4	2.0	0.3	39	8.1	1,490	351	259	1.266	1.200	1.129	WRS 2004
197	55$^{(d)}$	124	WNW	18.2	0.061	5	1.2	9.6	0.3	30	7.1	428	113	204	0.622	0.718	0.715	WRS 2004
600	Dolly	125	SSE	244.3	0.691	14	32.0	22.0	5.0	40	8.5	4,880	496	263	4.082	3.874	3.877	Primrose East (CNRL 2006)
521	Tucker	126	S	277.0	0.461	28	24.5	21.0	3.4	13	8.1	4,242	115	99	2.291	2.283	2.526	WRS 2004
533	McLean	128	NE	235.4	0.327	22	8.0	5.5	1.5	18	7.9	1,955	132	128	0.854	0.852	0.852	Primrose East (CNRL 2006)
522	Ethel	128	S	594.0	0.647	29	15.8	12.2	2.7	11	8.3	3,167	109	87	1.124	1.117	1.156	WRS 2004

Table 14 Critical Loads of Acidity for the 416 Lakes Included in the Assessment (continued)

Lake Identifier[(a)]	Lake Name/ Original Identifier	Distance [km][(b)]	Direction[(b)]	Gross Catchment Area [km^2]	Net Annual Inflow [m^3/s]	Calcium [mg/L]	Magnesium [mg/L]	Sodium [mg/L]	Potassium [mg/L]	DOC [mg/L]	pH	Alkalinity [μeq/L]	ANC_{org} [μeq/L]	SA_{org} [μeq/L]	Critical Load With Organic Acids [keq/ha/yr]	Critical Load Without Organic Acids [keq/ha/yr]	Literature Critical Load [keq/ha/yr]	Literature Critical Load/Gross Catchment Area/Net Annual Inflow Data Source
523	Hilda	129	S	79.8	0.051	21	37.8	73.1	6.7	17	8.4	6,540	198	123	1.523	1.507	1.505	WRS 2004
450	P99[(i)]	130	NNW	0.5	0.002	23	4.2	<0.1	0.7	21	7.5	1,500	108	148	1.307	1.344	1.370	WRS 2004
546	Cold	131	SSE	6,513.0	18.180	31	11.5	9.5	2.1	8	8.3	2,801	89	72	2.559	2.545	2.545	Primrose East (CNRL 2006)
451	PF1[(i)]	131	NNW	0.6	0.002	53	6.9	2.0	0.5	11	7.9	3,260	80	88	3.194	3.201	3.211	WRS 2004
456	PF2[(i)]	131	NNW	0.7	0.002	43	6.0	2.0	0.3	9	7.8	2,720	60	75	2.664	2.680	2.731	Meadow Creek Project (Petro Canada 2001)
457	PF3[(i)]	131	NW	0.7	0.002	42	6.3	2.0	0.6	15	7.9	2,600	109	112	2.171	2.173	2.175	WRS 2004
211	70[(d)]	131	W	11.5	0.038	9	1.8	2.2	0.6	33	7.3	413	142	219	0.564	0.645	0.646	WRS 2004
458	PF4[(i)]	131	NNW	0.3	0.001	64	10.2	2.0	0.5	16	7.7	3,980	98	118	3.910	3.929	3.835	WRS 2004
539	Field	132	SW	12.7	0.033	39	29.0	69.1	9.6	22	8.3	4,630	236	157	6.261	6.196	5.999	Primrose East (CNRL 2006)
596	Manatokan	135	S	409.3	1.152	35	27.0	8.5	7.1	16	8.7	4,050	243	120	4.058	3.949	3.965	Primrose East (CNRL 2006)
210	69[(d)]	135	W	12.6	0.041	5	1.0	1.6	0.3	25	6.7	214	60	172	0.245	0.359	0.355	WRS 2004
129	2[(d)], 15[(f)], E15(L15b)[(e)]	137	N	25.0	0.081	6	1.6	3.8	1.2	38	7.0	436	128	248	0.463	0.586	0.656	WRS 2004
135	3[(d)], 16[(f)]	137	NNE	10.9	0.037	11	5.8	8.4	0.4	17	8.7	1,782	247	123	1.584	1.449	2.070	WRS 2004
121	59[(d)], A59[(e)]	137	WNW	44.8	0.174	3	0.8	1.2	0.5	30	5.2	65	21	202	0.023	0.245	0.172	WRS 2004
405	P101[(i)]	138	NNW	1.1	0.004	16	4.9	<0.1	1.1	21	7.5	1,220	108	148	1.161	1.204	1.223	WRS 2004
212	71[(d)]	138	W	21.9	0.084	8	1.6	2.3	0.4	28	7.2	324	110	187	0.583	0.677	0.675	WRS 2004
479	PTH12[(i)]	140	N	1.2	0.004	20	6.2	2.0	0.1	25	7.6	1,340	140	172	1.583	1.618	1.598	WRS 2004
156	P98[(i)], P98[(e)]	141	NNW	1.9	0.007	12	3.9	0.9	0.6	31	7.3	694	135	208	0.918	1.001	0.942	WRS 2004
214	73[(d)]	142	W	24.9	0.092	6	1.9	2.9	0.9	21	7.1	3,555	76	147	0.546	0.629	0.632	WRS 2004
155	P97[(i)], P97[(e)]	142	NNW	1.8	0.006	6	1.9	0.9	0.8	29	6.8	295	82	198	0.302	0.418	0.365	WRS 2004
213	72[(d)]	142	W	7.7	0.025	7	2.1	1.8	0.5	20	6.7	221	50	143	0.469	0.565	0.561	WRS 2004
134	1[(d)], 25[(f)], 1(267)[(e)]	144	NNW	34.5	0.118	11	3.4	1.6	0.9	21	7.4	826	102	150	0.848	0.899	0.726	WRS 2004
200	58[(d)]	145	WNW	21.6	0.078	5	1.2	1.3	0.4	29	6.5	182	64	198	0.248	0.401	0.403	WRS 2004
154	P96[(i)], P96[(e)]	147	NNW	1.3	0.003	10	3.7	0.8	0.9	31	7.3	670	139	210	0.633	0.693	0.582	WRS 2004
416	P30[(i)]	147	N	1.8	0.006	44	9.3	6.0	1.0	18	7.5	3,093	96	130	3.230	3.264	1.192	WRS 2004
478	PTH11[(i)]	147	N	2.7	0.010	18	6.5	3.0	<0.1	20	7.3	1,360	86	142	1.605	1.669	1.661	Kirby (Rio Alta 2002)
608	Suncor_VS_UW1	149	NNW	5.8	0.017	53	20.2	38.0	2.3	18	7.9	3,990	126	129	5.476	5.478	-	
467	PM4[(i)]	149	N	17.4	0.066	21	5.6	4.0	0.2	26	7.6	1,480	146	178	1.867	1.906	1.874	WRS 2004
215	Long [(h)]	149	W	31.1	0.111	12	3.3	3.5	1.0	22	7.5	692	113	153	1.035	1.080	1.075	WRS 2004
425	P47[(i)]	150	N	16.7	0.063	21	5.6	3.0	<0.1	37	7.8	1,460	247	245	1.856	1.853	1.842	Meadow Creek Project (Petro Canada 2001)
58	Shipyard	151	NNW	42.9	0.130	45	10.1	14.6	2.0	20	7.6	3,227	109	139	3.473	3.501	3.154	WRS 2004
449	P95[(i)]	152	NNW	1.6	0.006	22	7.1	10.0	0.5	30	7.5	1,580	154	203	2.249	2.304	2.319	WRS 2004
424	P46[(i)]	152	N	1.4	0.005	30	7.9	4.0	<0.1	37	8.3	2,220	384	245	2.576	2.427	2.447	Meadow Creek Project (Petro Canada 2001)
140	L5[(j)], P28[(i)]	154	N	11.8	0.048	9	2.4	0.3	0.2	27	7.1	591	99	186	0.653	0.764	0.748	WRS 2004
84	L8[(j)], L8[(e)]	154	N	10.6	0.045	6	2.3	2.3	0.1	19	7.0	398	63	134	0.584	0.679	0.626	WRS 2004
216	75[(d)]	156	W	4.1	0.007	15	5.0	3.5	1.1	21	8.5	1,008	259	150	0.717	0.660	0.662	WRS 2004
319	L6[(j)]	157	N	32.4	0.137	15	4.0	0.5	0.1	21	7.7	1,030	124	149	1.339	1.373	1.463	WRS 2004
83	L7[(j)], L7[(e)]	159	N	21.5	0.101	4	1.2	0.6	0.2	30	6.4	203	56	200	0.187	0.401	0.405	WRS 2004
217	Pelican	160	W	283.2	0.962	15	4.6	4.1	1.5	26	7.9	978	184	180	1.365	1.361	1.361	OPTI/RAMP (OPTI Canada Inc 2000)
190	46[(d)]	161	WNW	33.7	0.131	4	1.0	0.8	0.3	24	6.5	160	51	166	0.189	0.330	0.332	WRS 2004
161	49[(d)], A300[(e)]	164	WNW	25.0	0.026	6	1.2	1.4	1.4	29	7.1	315	104	196	0.105	0.135	0.131	WRS 2004
191	48[(d)]	164	WNW	3.3	0.008	6	0.8	0.8	0.2	31	7.0	202	104	206	0.166	0.244	0.241	WRS 2004
329	Mildred	164	NNW	9.1	0.015	54	15.0	23.0	1.2	7	8.2	3,580	70	66	2.494	2.491	2.497	WRS 2004
422	P44[(i)]	164	N	2.3	0.009	26	9.5	15.0	0.8	51	9.0	2,520	983	330	4.044	3.250	3.261	WRS 2004
120	47[(d)], A47[(e)]	165	WNW	8.6	0.034	4	0.8	0.7	0.7	15	6.4	154	31	114	0.187	0.289	0.279	WRS 2004
150	P27[(i)], P27[(e)]	165	N	4.0	0.017	3	0.9	0.4	0.1	34	5.2	76	23	227	-0.019	0.254	0.307	WRS 2004
82	170[(d)], 14[(f)], L4[(j)], A170(L4)[(e)]	165	N	18.2	0.083	3	0.9	0.6	0.2	27	6.0	135	36	185	0.069	0.283	0.245	Horizon (Canadian Natural 2002)
423	P45[(i)]	166	N	1.3	0.004	38	12.3	4.0	1.6	39	8.3	2,880	405	257	3.035	2.893	2.914	WRS 2004
322	L15[(j)]	166	N	8.0	0.026	7	2.5	13.0	0.7	36	7.5	510	180	239	1.000	1.061	1.202	WRS 2004
477	PTH10[(i)]	166	N	8.4	0.028	11	3.6	1.0	0.2	20	7.0	700	66	142	0.774	0.852	0.817	Kirby (Rio Alta, 2002)
137	Wood Buffalo	167	WNW	81.4	0.332	9	2.4	2.3	0.4	24	6.9	624	74	166	0.772	0.891	0.728	WRS 2004
535	Turnor	167	NE	2,551.5	3.579	10	4.0	4.7	1.3	8	7.3	1,140	37	72	0.430	0.445	0.445	Primrose East (CNRL 2006)
485	PTH9[(i)]	167	N	2.6	0.007	13	4.3	2.0	0.5	17	7.4	940	80	124	0.841	0.879	0.878	Kirby (Rio Alta 2002)
314	Sandy [(d)]	169	W	395.4	1.084	22	6.2	3.9	1.6	16	8.1	1,368	134	117	1.543	1.528	1.526	WRS 2004
193	50[(d)]	170	WNW	38.3	0.148	11	2.5	0.9	0.5	31	8.4	632	354	210	1.089	0.913	0.907	WRS 2004
320	L9[(j)]	170	N	33.4	0.135	19	5.0	4.0	0.2	16	8.5	1,560	202	120	1.976	1.870	1.960	WRS 2004
189	45[(d)]	171	WNW	119.5	0.496	15	3.3	2.6	0.5	25	8.6	905	338	172	1.602	1.384	1.384	WRS 2004

Table 14 Critical Loads of Acidity for the 416 Lakes Included in the Assessment (continued)

Lake Identifier$^{(a)}$	Lake Name/ Original Identifier	Distance [km]$^{(b)}$	Direction$^{(b)}$	Gross Catchment Area [km^2]	Net Annual Inflow [m^3/s]	Calcium [mg/L]	Magnesium [mg/L]	Sodium [mg/L]	Potassium [mg/L]	DOC [mg/L]	pH	Alkalinity [μeq/L]	ANC$_{org}$ [μeq/L]	SA$_{org}$ [μeq/L]	Critical Load With Organic Acids [keq/ha/yr]	Critical Load Without Organic Acids [keq/ha/yr]	Literature Critical Load [keq/ha/yr]	Literature Critical Load/Gross Catchment Area/Net Annual Inflow Data Source
119	42$^{(d)}$, A42$^{(e)}$	172	WNW	25.1	0.088	6	1.4	3.4	0.5	38	6.8	283	107	252	0.402	0.561	0.335	WRS 2004
414	P25$^{(i)}$	172	N	8.6	0.036	17	3.8	2.0	0.1	29	7.7	1,100	177	196	1.548	1.573	1.569	WRS 2004
445	P9$^{(i)}$	172	N	4.9	0.020	23	5.0	2.0	0.2	30	7.8	1,500	200	203	1.976	1.979	1.967	WRS 2004
188	44$^{(d)}$	173	WNW	156.9	0.654	13	2.8	1.9	0.5	22	7.7	781	141	156	1.189	1.208	1.210	WRS 2004
306	Horsetail	173	WNW	124.7	0.393	10	2.6	1.0	0.5	15	6.9	583	47	115	0.608	0.675	0.674	WRS 2004
413	P24$^{(i)}$	174	N	7.6	0.032	50	11.0	6.0	1.0	20	7.8	3,460	134	142	4.781	4.792	0.868	WRS 2004
440	P8$^{(i)}$	174	N	2.1	0.008	9	2.1	<0.1	0.2	38	7.0	500	125	251	0.531	0.685	0.708	WRS 2004
152	P7$^{(i)}$, P7$^{(e)}$	174	N	1.9	0.007	4	1.3	0.4	0.1	27	6.4	171	54	187	0.151	0.307	0.387	WRS 2004
606	P2	174	NNW	9.5	0.018	84	14.6	16.5	1.8	19	8.2	5,375	178	134	3.634	3.608	3.400	Kirby (Rio Alta 2002)
432	P6$^{(i)}$	175	N	4.0	0.016	20	4.0	1.0	0.2	30	7.7	1,280	183	203	1.561	1.584	1.584	Meadow Creek Project (Petro Canada 2001)
316	D254$^{(h)}$	176	NW	390.6	1.484	22	6.3	6.2	0.8	20	8.4	1,564	230	139	2.275	2.167	2.164	WRS 2004
421	P43$^{(i)}$	177	N	3.5	0.014	12	2.9	0.0	0.2	17	7.5	780	87	124	0.883	0.929	0.951	WRS 2004
318	L3$^{(j)}$	178	N	7.2	0.030	14	3.0	0.5	0.1	-	7.8	806	-	-	-	1.186	1.255	WRS 2004
149	P23$^{(i)}$, P23$^{(e)}$	178	N	7.3	0.030	10	2.4	1.4	0.1	18	7.6	614	108	133	0.813	0.845	0.462	WRS 2004
466	PM3$^{(i)}$	178	N	1.0	0.004	13	3.1	<0.1	<0.1	19	7.4	840	89	136	1.038	1.100	1.125	WRS 2004
465	PM2$^{(i)}$	178	N	0.7	0.003	11	2.6	<0.1	0.2	18	7.1	700	65	130	0.801	0.886	0.925	WRS 2004
317	L2$^{(j)}$	179	N	9.8	0.041	18	3.0	0.5	0.1	-	7.8	1,020	-	-	-	1.452	1.554	WRS 2004
56	UW6$^{(g)}$	179	NNW	9.7	0.017	32	8.9	9.5	1.4	24	8.0	2,430	183	166	1.480	1.471	1.617	WRS 2004
464	PM1$^{(i)}$	179	N	0.5	0.002	<1	<0.1	<0.1	0.3	21	4.2	50	6	148	-0.273	-0.088	-0.038	WRS 2004
55	UW5$^{(g)}$	179	NNW	12.4	0.023	49	10.9	8.0	1.0	16	8.2	3,450	146	118	2.192	2.175	2.200	WRS 2004
605	P1	179	NNW	18.3	0.035	77	13.4	8.5	1.3	11	8.1	5,125	92	86	3.158	3.154	3.248	Kirby (Rio Alta 2002)
52	UW2$^{(g)}$	179	NNW	36.9	0.070	36	7.0	4.5	2.9	9	8.1	2,610	75	75	1.533	1.533	1.537	WRS 2004
53	UW3$^{(g)}$	179	NNW	20.6	0.039	72	12.6	7.7	1.0	13	7.9	4,693	94	102	2.915	2.920	2.946	WRS 2004
51	UW1$^{(g)}$	179	NNW	20.5	0.039	71	12.6	8.3	1.1	14	8.0	4,613	106	104	2.920	2.919	3.021	Horizon (Canadian Natural 2002)
607	P4	180	NNW	6.6	0.012	43	7.1	4.3	0.8	14	8.0	2,815	105	104	1.681	1.681	1.183	Primrose East (CNRL 2006)
54	UW4$^{(g)}$	180	NNW	12.6	0.023	71	12.4	13.5	1.1	18	8.2	4,800	164	130	2.949	2.930	2.939	Jackpine Mine (Shell 2002)
88	168$^{(d)}$, 12$^{(f)}$, L14$^{(j)}$	180	N	29.5	0.096	13	4.2	2.9	0.4	22	8.2	1,104	215	152	1.152	1.087	1.062	WRS 2004
81	L1$^{(j)}$, L1$^{(e)}$	181	N	4.3	0.016	3	0.9	0.6	0.3	0	6.3	110	0	21	0.183	0.208	0.200	WRS 2004
532	unnamed	181	NE	21.0	0.107	8	3.5	4.3	1.8	9	7.0	860	29	74	1.307	1.380	1.380	Primrose East (CNRL, 2006)
87	167$^{(d)}$, L13$^{(j)}$	181	N	15.7	0.047	9	3.0	1.8	0.2	19	7.5	743	99	134	0.650	0.684	0.665	Horizon (Canadian Natural, 2002)
447	P91$^{(i)}$	182	NNW	13.7	0.043	33	12.1	14.0	2.1	24	7.7	3,120	147	166	3.144	3.163	3.161	WRS 2004
153	P94$^{(i)}$, P94$^{(e)}$	182	NNW	0.7	0.002	13	5.4	6.6	1.3	48	7.4	799	216	309	1.044	1.123	1.030	WRS 2004
20	Isadore's	182	NNW	28.0	0.088	54	22.9	7.0	1.8	11	7.9	3,717	78	87	4.812	4.821	3.906	WRS 2004
446	P90$^{(i)}$	182	NNW	0.6	0.002	24	8.7	13.0	2.7	26	7.9	2,440	190	178	1.933	1.925	1.963	WRS 2004
86	166$^{(d)}$, L12$^{(j)}$	183	N	7.1	0.022	11	3.6	2.9	0.2	27	8.9	845	463	183	1.113	0.844	0.813	WRS 2004
4	Kearl	184	N	71.1	0.169	20	7.2	10.8	1.0	22	8.0	1,897	171	153	1.534	1.521	1.416	Jackpine Mine (Shell 2002)
187	41$^{(d)}$	185	WNW	72.7	0.300	14	4.6	9.4	0.4	22	7.8	1,111	145	156	1.856	1.870	1.863	WRS 2004
420	P4$^{(i)}$	188	NNW	2.6	0.007	41	14.4	18.0	1.1	20	8.2	3,700	190	142	3.214	3.176	3.154	WRS 2004
78	UNL-1$^{(g)}$	191	N	13.1	0.033	72	31.4	3.0	1.0	17	8.2	5,853	160	126	5.019	4.992	3.332	Kearl (Imperial 2005)
304	D226$^{(h)}$	192	WNW	14.5	0.022	33	8.9	9.6	2.2	23	8.2	1,467	223	159	1.324	1.294	1.285	WRS 2004
415	P3$^{(i)}$	195	N	1.9	0.005	50	11.0	6.0	1.0	20	7.8	3,460	134	142	2.745	2.752	2.717	WRS 2004
79	UNL-2$^{(g)}$	195	N	7.4	0.021	72	31.4	3.0	1.0	17	8.2	5,853	160	126	5.695	5.664	4.289	WRS 2004
419	P38$^{(i)}$	195	N	0.3	0.001	12	4.3	1.0	<0.1	16	7.5	860	82	118	0.566	0.588	0.621	WRS 2004
321	L11$^{(j)}$	195	N	19.7	0.059	8	2.5	0.5	0.1	28	8.1	560	239	187	0.550	0.501	0.596	WRS 2004
284	Big Snuff	196	N	17.3	0.054	9	3.7	1.3	0.1	17	7.5	608	90	123	0.706	0.739	0.741	WRS 2004
302	D223$^{(h)}$	196	NW	12.0	0.029	17	7.1	4.3	2.0	32	9.3	976	795	218	1.681	1.235	1.237	WRS 2004
411	P2$^{(i)}$	197	N	2.6	0.006	42	11.8	1.0	0.7	16	8.3	2,960	166	118	2.352	2.315	2.317	WRS 2004
80	P5$^{(i)}$, UNL-3$^{(g)}$	197	N	3.0	0.007	38	13.6	1.9	0.9	13	7.9	2,897	96	102	2.362	2.367	2.034	WRS 2004
373	22$^{(f)}$	200	NW	505.6	1.719	20	6.0	21.0	1.6	-	7.7	2,400	-	-	-	2.545	2.542	WRS 2004
85	164$^{(d)}$, 17$^{(f)}$, L10$^{(j)}$	201	N	11.4	0.035	16	6.1	1.2	0.3	11	8.6	1,453	142	87	1.302	1.249	1.039	WRS 2004
534	Proudfoot	202	NE	31.3	0.136	3	1.7	2.0	1.0	14	7.0	387	45	106	0.339	0.422	0.422	Primrose East (CNRL 2006)
300	D221$^{(h)}$	203	NW	7.0	0.001	30	22.4	49.1	11.9	38	8.6	4,797	487	249	0.267	0.257	0.255	WRS 2004
19	Calumet	205	NNW	57.5	0.034	48	18.0	74.7	4.8	51	7.8	5,267	343	332	1.319	1.317	0.916	Kearl (Imperial 2005)
12	LK-7$^{(g)}$	205	NNW	2.1	0.001	30	10.1	4.5	2.0	30	7.7	2,600	183	203	0.402	0.405	0.406	Muskeg River Mine Expansion (Shell 2005)
89	Rabbit	206	NW	14.6	0.035	22	11.5	28.0	4.5	53	8.4	2,910	573	340	2.650	2.476	2.693	WRS 2004
488	PW3$^{(i)}$	206	NNW	0.7	0.003	13	3.6	2.0	3.8	17	7.3	1,080	73	124	1.285	1.350	1.352	Kirby (Rio Alta, 2002)
5	McClelland	206	N	230.4	0.393	24	16.8	4.6	3.0	13	8.3	2,649	131	99	1.508	1.491	1.419	Muskeg River Mine Expansion (Shell 2005)

Table 14 Critical Loads of Acidity for the 416 Lakes Included in the Assessment (continued)

Lake Identifier(a)	Lake Name/ Original Identifier	Distance [km](b)	Direction(b)	Gross Catchment Area $[km^2]$	Net Annual Inflow $[m^3/s]$	Calcium [mg/L]	Magnesium [mg/L]	Sodium [mg/L]	Potassium [mg/L]	DOC [mg/L]	pH	Alkalinity [μeq/L]	ANC_{org} [μeq/L]	SA_{org} [μeq/L]	Critical Load With Organic Acids [keq/ha/yr]	Critical Load Without Organic Acids [keq/ha/yr]	Literature Critical Load [keq/ha/yr]	Literature Critical Load/Gross Catchment Area/Net Annual Inflow Data Source
283	163(d)	206	N	10.1	0.024	22	10.0	0.8	0.2	19	8.4	1,715	206	136	1.506	1.452	1.448	WRS 2004
18	Lillian	206	NNW	7.4	0.004	66	18.5	8.8	2.3	23	7.6	5,230	122	159	0.776	0.781	0.563	Fort Hills (True North Energy 2001)
406	P11(i)	207	NNW	2.0	0.008	10	4.4	10.0	0.9	32	7.4	940	150	215	1.505	1.586	1.592	WRS 2004
336	L51(j)	207	NW	65.9	0.180	14	5.0	6.0	1.4	28	8.5	1,140	354	189	1.287	1.145	1.144	WRS 2004
484	PTH8(i)	207	N	0.6	0.002	16	8.5	<0.1	<0.1	25	7.7	1,300	153	172	1.099	1.114	1.133	Kirby (Rio Alta 2002)
487	PW2(i)	207	NNW	0.6	0.002	26	9.0	17.0	1.1	31	7.9	2,260	226	209	3.230	3.209	3.277	Kirby (Rio Alta 2002)
301	D222(h)	207	NW	4.6	0.001	42	14.6	9.2	5.7	36	8.7	2,947	507	238	0.277	0.259	0.259	WRS 2004
337	L52(j)	209	NW	11.1	0.034	14	4.4	6.0	3.1	21	7.4	1,160	99	148	1.249	1.297	1.299	WRS 2004
418	P35(i)	209	N	1.3	0.003	17	7.8	<0.1	0.3	20	8.1	1,460	174	142	1.050	1.027	1.035	WRS 2004
407	P14(i)	210	NNW	8.9	0.034	22	6.9	9.0	0.8	37	7.6	1,300	207	245	2.331	2.376	2.159	WRS 2004
282	162(d)	210	N	10.2	0.009	28	12.4	1.3	0.4	15	8.0	2,265	123	113	0.694	0.691	0.692	WRS 2004
486	PW1(i)	210	NNW	1.8	0.008	14	5.6	7.0	1.6	31	7.2	760	122	209	1.762	1.877	1.875	WRS 2004
483	PTH7(i)	210	N	0.9	0.003	24	13.7	<0.1	<0.1	24	8.0	2,100	191	166	1.944	1.922	1.961	Kirby (Rio Alta 2002)
443	P86(i)	210	NNW	3.8	0.015	39	10.9	22.0	2.2	31	7.7	2,780	190	209	4.696	4.720	4.718	WRS 2004
148	P13(i), P13(e)	211	NNW	3.8	0.012	11	4.5	8.2	0.7	45	8.0	880	351	292	1.300	1.241	0.860	WRS 2004
339	L54(j)	212	NW	236.9	0.915	43	13.0	15.0	1.8	23	7.6	3,140	123	158	4.639	4.681	4.675	Meadow Creek Project (Petro Canada 2001)
338	L53(j)	213	NW	50.6	0.180	44	11.7	17.0	2.2	28	7.4	2,100	134	190	4.294	4.357	4.352	WRS 2004
409	P17(i)	214	NNW	0.5	0.002	21	5.6	7.0	1.8	29	7.3	1,040	125	196	1.982	2.065	2.102	WRS 2004
417	P34(i)	214	N	0.9	0.002	20	11.0	<0.1	<0.1	24	7.8	1,660	160	166	1.304	1.309	1.308	WRS 2004
6	LK-1(g)	214	NNW	3.8	0.002	11	104.7	215.7	28.3	41	9.1	16,013	870	271	3.886	3.768	3.596	Jackpine Mine (Shell 2002)
408	P16(i)	214	NNW	1.0	0.004	15	4.3	5.0	0.9	33	6.9	460	100	221	1.533	1.698	1.676	Meadow Creek Project (Petro Canada 2001)
410	P18(i)	215	NNW	0.6	0.002	15	4.5	5.0	2.2	22	7.5	780	113	154	1.471	1.519	1.550	WRS 2004
482	PTH6(i)	215	N	0.9	0.002	23	10.9	<0.1	0.3	25	7.8	1,840	167	172	1.634	1.638	1.644	WRS 2004
281	161(d)	216	N	8.1	0.011	24	13.6	4.7	1.2	16	8.5	2,294	194	117	1.063	1.031	1.028	WRS 2004
102	33(f), L33(j)	217	NNW	10.2	0.022	35	9.0	5.0	2.2	15	8.4	2,584	168	113	1.843	1.805	2.258	WRS 2004
526	Preston	218	NNE	252.5	1.204	4	1.8	2.8	1.0	3	6.8	500	8	39	0.595	0.642	0.641	WRS 2004
481	PTH5(i)	218	N	1.0	0.002	29	12.6	5.0	1.2	18	8.0	2,440	143	130	2.030	2.020	2.005	WRS 2004
475	PT9(i)	218	NNW	0.6	0.003	15	4.7	2.0	1.3	16	7.9	1,120	117	118	1.619	1.621	1.616	WRS 2004
278	157(d)	218	N	42.3	0.103	39	14.6	5.0	1.1	19	8.3	2,959	194	134	2.586	2.540	2.536	WRS 2004
280	160(d)	218	N	24.4	0.063	23	9.3	1.9	0.5	14	8.3	1,804	145	105	1.618	1.586	1.584	WRS 2004
528	Lloyd	219	NNE	4,250.0	22.599	3	1.0	1.4	1.0	4	6.9	296	12	45	0.353	0.409	0.409	WRS 2004
103	Audet	220	N	96.5	0.208	32	16.1	6.5	2.2	18	8.2	2,941	161	127	2.187	2.165	2.005	Horizon (Canadian Natural 2002)
374	Carrot	221	NW	179.8	0.581	20	6.0	7.0	1.6	-	7.3	1,860	-	-	-	1.797	1.794	WRS 2004
104	Johnson	222	N	73.5	0.151	33	15.7	6.4	1.1	14	8.4	2,955	160	108	2.082	2.049	2.296	WRS 2004
279	158(d)	222	N	14.5	0.029	25	17.4	2.9	1.0	17	8.5	2,568	212	121	1.832	1.774	1.773	WRS 2004
299	Chipewyan	222	NW	100.0	0.322	24	9.2	9.1	2.3	14	8.9	2,053	234	104	2.501	2.369	2.366	WRS 2004
10	LK-5(g)	223	NNW	0.8	0.002	21	7.7	7.0	2.9	11	7.5	1,413	55	86	1.641	1.667	1.412	WRS 2004
341	L56(j)	224	NW	37.9	0.168	11	3.0	3.0	0.8	21	7.2	700	82	149	1.124	1.217	1.214	Meadow Creek Project (Petro Canada 2001)
444	P87(i)	224	NNW	4.1	0.022	11	3.2	<0.1	0.0	18	7.3	660	77	130	1.158	1.246	1.225	WRS 2004
442	P85(i)	224	NNW	2.2	0.011	11	3.1	<0.1	0.2	24	7.2	580	94	166	1.100	1.220	1.252	WRS 2004
17	LK-12(g)	224	NNW	2.5	0.008	16	6.5	2.7	1.2	17	7.2	887	64	122	1.313	1.370	1.054	WRS 2004
340	L55(j)	225	NW	26.2	0.093	22	6.0	4.0	1.3	13	7.8	1,540	87	98	1.914	1.926	1.922	WRS 2004
441	P84(i)	226	NNW	0.9	0.005	10	3.3	<0.1	0.5	18	7.1	620	65	130	1.028	1.133	1.161	WRS 2004
11	LK-6(g)	226	NNW	3.8	0.011	24	7.0	2.7	1.6	12	7.5	1,300	61	96	1.613	1.643	1.511	Jackpine Mine (Shell 2002)
474	PT8(i)	226	NNW	0.1	0.000	19	7.0	3.0	1.5	13	7.8	1,000	87	100	1.821	1.835	1.575	WRS 2004
436	P70(i)	226	NNW	1.7	0.009	6	1.8	<0.1	0.2	29	6.6	280	67	196	0.412	0.635	0.671	WRS 2004
7	LK-2(g)	227	NNW	7.3	0.018	4	1.2	<0.1	0.3	14	6.7	200	34	106	0.115	0.172	0.212	Jackpine Mine (Shell 2002)
430	P52(i)	229	NNW	0.9	0.001	32	27.5	17.0	13.6	30	8.3	3,600	312	203	1.689	1.652	1.561	WRS 2004
473	PT6(i)	229	NNW	0.2	0.000	36	18.5	8.0	6.2	33	8.4	3,140	374	221	1.354	1.301	1.592	WRS 2004
91	Namur	230	NNW	224.0	0.325	6	2.0	2.4	1.1	10	7.2	414	39	83	0.222	0.242	0.302	WRS 2004
426	P48(i)	230	NNW	4.6	0.021	12	4.7	6.0	0.4	24	7.7	820	147	166	1.688	1.716	1.674	WRS 2004
525	Forrest	232	NNE	434.0	2.071	4	1.8	2.0	1.0	2	6.9	475	6	34	0.533	0.574	0.574	WRS 2004
323	S. Gardiner	232	NNW	1,201.3	3.324	14	4.0	2.0	0.8	10	7.6	1,066	57	81	0.905	0.926	0.937	WRS 2004
277	153(d)	232	N	17.4	0.042	14	4.0	1.3	0.5	17	8.7	934	243	124	0.868	0.777	0.775	WRS 2004
346	Canopener	232	NNW	10.9	0.021	20	6.0	2.0	0.5	21	7.6	1,380	123	149	0.905	0.921	1.232	WRS 2004
345	Buoy	233	NNW	25.2	0.065	27	8.0	3.0	1.1	12	8.3	2,080	129	95	1.730	1.703	1.898	WRS 2004
524	Patterson	235	NNE	265.0	1.194	4	1.2	1.4	1.0	3	6.9	384	8	38	0.370	0.412	0.412	WRS 2004

Table 14 Critical Loads of Acidity for the 416 Lakes Included in the Assessment (continued)

Lake Identifier(a)	Lake Name/ Original Identifier	Distance [km](b)	Direction(b)	Gross Catchment Area [km^2]	Net Annual Inflow [m^3/s]	Calcium [mg/L]	Magnesium [mg/L]	Sodium [mg/L]	Potassium [mg/L]	DOC [mg/L]	pH	Alkalinity [μeq/L]	ANC$_{org}$ [μeq/L]	SA$_{org}$ [μeq/L]	Critical Load With Organic Acids [keq/ha/yr]	Critical Load Without Organic Acids [keq/ha/yr]	Literature Critical Load [keq/ha/yr]	Literature Critical Load/Gross Catchment Area/Net Annual Inflow Data Source
428	P50(i)	235	NNW	2.9	0.015	30	10.6	3.0	0.5	15	8.2	2,360	143	112	4.024	3.974	3.969	WRS 2004
434	P61(i)	235	NNW	0.8	0.004	11	3.4	<0.1	0.5	23	7.5	700	118	160	1.200	1.269	1.312	WRS 2004
429	P51(i)	235	NNW	0.4	0.002	12	4.9	3.0	2.1	13	7.3	680	56	100	1.359	1.416	1.396	WRS 2004
324	N. Gardiner	235	NNW	1,026.5	2.748	15	4.0	2.0	0.8	15	7.8	1,050	96	111	0.926	0.939	0.970	WRS 2004
412	P20(i)	236	NNW	0.8	0.004	9	3.1	1.0	<0.1	26	7.5	580	133	178	0.995	1.064	1.059	WRS 2004
431	P54(i)	236	NNW	0.4	0.001	11	5.0	2.0	0.8	5	7.8	880	33	51	0.918	0.935	0.945	WRS 2004
472	PT5(i)	236	NNW	1.5	0.008	8	2.9	<0.1	0.5	21	7.5	560	108	148	0.815	0.879	0.825	WRS 2004
435	P69(i)	237	NNW	1.0	0.006	8	2.8	1.0	0.2	26	7.4	460	122	178	0.940	1.040	1.031	WRS 2004
438	P77(i)	237	NNW	1.3	0.006	10	2.8	<0.1	<0.1	27	7.1	560	97	184	0.878	1.018	1.011	Meadow Creek Project (Petro Canada 2001)
439	P79(i)	237	NNW	2.3	0.012	10	2.6	<0.1	<0.1	30	7.0	520	99	203	0.848	1.018	1.005	WRS 2004
471	PT4(i)	237	NNW	1.7	0.009	12	3.2	<0.1	<0.1	28	7.6	680	157	190	1.211	1.267	1.240	WRS 2004
151	P49(i), P49(e)	237	NNW	0.8	0.004	3	1.3	1.2	0.4	17	6.7	178	44	122	0.234	0.363	0.329	WRS 2004
93	Legend	237	NW	93.1	0.177	3	0.7	0.7	0.6	10	6.9	219	27	79	0.076	0.106	0.112	WRS 2004
470	PT3(i)	240	NNW	0.6	0.003	10	3.4	1.0	0.2	30	7.5	600	154	203	1.130	1.209	1.198	WRS 2004
527	Beet	241	NNE	456.1	2.408	4	1.5	2.0	1.0	3	6.9	440	9	39	0.571	0.622	0.622	WRS 2004
325	L21(j)	242	NNW	103.2	0.120	11	3.5	4.0	1.0	<1	7.9	888	1	22	0.345	0.353	0.619	WRS 2004
326	Sand	243	NNW	604.6	1.602	14	4.0	2.0	0.7	16	8.0	1,036	129	118	0.894	0.885	0.927	WRS 2004
433	P60(i)	243	NNW	3.5	0.018	14	5.6	3.0	0.6	22	7.7	1,000	135	154	1.996	2.029	2.030	WRS 2004
333	L45(j)	244	N	36.1	0.069	17	8.0	0.5	0.4	9	8.0	1,490	71	74	0.881	0.883	0.992	WRS 2004
334	L48(j)	244	NNW	102.6	0.278	16	4.0	2.0	0.3	29	7.4	1,160	137	193	0.934	0.982	1.020	WRS 2004
328	Clear	245	NNW	107.2	0.303	12	4.5	0.5	0.3	21	7.4	734	97	148	0.779	0.824	0.841	WRS 2004
468	PT1(i)	246	NNW	1.3	0.005	14	5.3	<0.1	<0.1	19	8.0	1,000	151	136	1.356	1.336	1.200	WRS 2004
476	PTH1(i)	247	N	1.0	0.001	27	12.4	1.0	0.7	10	8.3	2,360	104	82	1.023	1.013	0.985	WRS 2004
437	P72(i)	248	NNW	1.7	0.009	4	2.1	4.0	0.3	33	5.9	160	41	221	0.484	0.760	0.760	WRS 2004
469	PT2(i)	249	NNW	1.0	0.005	4	1.7	2.0	0.2	30	5.0	50	17	203	0.231	0.505	0.501	WRS 2004
271	145(d)	249	N	18.6	0.026	30	12.1	1.2	0.9	-	8.4	2,428	-	-	-	1.123	1.123	Meadow Creek Project (Petro Canada 2001)
108	Waterlily	249	NNW	23.2	0.085	7	2.4	3.5	0.6	22	7.7	444	139	154	0.717	0.735	0.730	WRS 2004
92	Otasan	249	NNW	23.4	0.043	3	1.0	0.8	0.4	12	6.7	169	32	94	0.071	0.107	0.058	WRS 2004
344	L59(j)	249	NNW	201.4	0.521	6	2.0	2.0	0.4	28	7.3	364	115	190	0.336	0.397	0.407	WRS 2004
343	L58(j)	250	NW	14.4	0.029	13	4.0	1.0	0.1	19	9.3	1,000	464	138	0.817	0.608	0.683	Meadow Creek Project (Petro Canada 2001)
275	151(d)	250	N	92.0	0.268	4	1.6	2.2	0.8	13	7.2	308	50	100	0.315	0.361	0.363	WRS 2004
107	L60(j), L60(e)	251	NNW	60.2	0.163	6	2.1	2.7	0.6	18	7.2	296	72	131	0.409	0.459	0.427	WRS 2004
480	PTH2(i)	251	N	1.2	0.002	29	11.0	1.0	0.5	9	8.1	2,320	78	75	1.305	1.303	1.121	WRS 2004
342	L57(j)	251	NW	198.4	0.512	19	5.0	2.0	0.1	31	7.7	1,160	196	209	1.109	1.119	1.129	WRS 2004
327	Eaglenest	251	NNW	128.4	0.307	11	4.0	2.0	0.5	19	7.5	674	95	134	0.652	0.682	0.775	WRS 2004
270	143(d)	251	N	28.3	0.045	22	7.6	1.3	0.6	-	8.1	1,657	-	-	-	0.877	0.876	WRS 2004
99	144(d), L43(j)	251	N	23.0	0.047	20	7.4	0.9	0.6	2	8.1	1,616	20	36	1.032	1.042	1.037	WRS 2004
332	L44(j)	251	N	9.4	0.002	16	9.5	0.5	0.6	7	8.7	1,980	98	61	0.101	0.098	0.100	WRS 2004
274	149(d)	251	N	7.1	0.013	34	8.6	1.0	0.6	6	8.3	2,678	61	56	1.385	1.382	1.380	WRS 2004
276	152(d)	252	N	21.9	0.028	29	7.0	1.0	0.6	-	8.3	1,971	-	-	-	0.792	0.791	Meadow Creek Project (Petro Canada 2001)
273	148(d)	253	N	6.2	0.010	23	5.7	0.9	0.6	-	8.2	1,552	-	-	-	0.813	0.812	WRS 2004
98	146(d), L40(j)	253	N	5.6	0.002	16	3.9	0.8	0.6	6	8.0	1,219	48	58	0.093	0.094	0.094	Horizon (Canadian Natural, 2002)
330	L41(j)	254	N	36.5	0.046	20	7.0	0.5	0.6	13	7.8	1,620	85	98	0.604	0.609	0.608	WRS 2004
105	150(d), 9(f), L39(j), A-150(L39)(e)	256	N	19.2	0.050	3	1.3	2.2	0.6	14	6.8	252	37	104	0.177	0.233	0.271	WRS 2004
106	Bayard	256	NNW	57.2	0.169	6	2.0	3.5	0.8	21	6.7	278	54	147	0.424	0.510	0.333	WRS 2004
269	142(d)	256	N	36.6	0.087	26	8.5	1.2	0.7	7	8.3	1,933	68	61	1.507	1.501	1.501	Meadow Creek Project (Petro Canada 2001)
268	141(d)	256	N	42.8	0.078	26	8.9	1.2	0.8	-	8.3	1,951	-	-	-	1.153	1.150	WRS 2004
262	Dianne	256	NNW	295.8	0.515	37	10.1	10.2	3.3	15	7.9	2,377	109	111	1.711	1.712	1.709	WRS 2004
100	27(f), L47(j), L47(e)	257	NNW	49.2	0.102	8	2.5	3.0	1.0	20	6.7	276	53	143	0.371	0.430	0.261	WRS 2004
335	L50(j)	258	NNW	14.4	0.028	7	4.0	3.0	0.2	30	7.0	520	98	203	0.391	0.455	0.512	WRS 2004
267	139(d)	258	N	10.5	0.011	17	5.6	1.3	0.7	6	8.1	1,321	50	57	0.428	0.430	0.428	WRS 2004
265	Pearson	258	N	16.8	0.014	22	6.7	1.7	0.5	-	8.1	1,599	-	-	-	0.432	0.433	Meadow Creek Project (Petro Canada 2001)
331	L42(j)	259	N	49.6	0.074	24	8.5	0.5	0.6	5	8.1	1,994	42	49	0.876	0.879	0.878	WRS 2004

Table 14 Critical Loads of Acidity for the 416 Lakes Included in the Assessment (continued)

Lake Identifier[a]	Lake Name/ Original Identifier	Distance [km][b]	Direction[b]	Gross Catchment Area [km^2]	Net Annual Inflow [m^3/s]	Calcium [mg/L]	Magnesium [mg/L]	Sodium [mg/L]	Potassium [mg/L]	DOC [mg/L]	pH	Alkalinity [μeq/L]	ANC$_{org}$ [μeq/L]	SA$_{org}$ [μeq/L]	Critical Load With Organic Acids [keq/ha/yr]	Critical Load Without Organic Acids [keq/ha/yr]	Literature Critical Load [keq/ha/yr]	Literature Critical Load/Gross Catchment Area/Net Annual Inflow Data Source
272	Poplar	259	N	48.0	0.117	31	7.6	1.2	0.8	8	8.4	1,979	87	69	1.690	1.676	1.674	OPTI/RAMP (OPTI Canada Inc. 2000)
266	Kress	259	N	31.0	0.066	12	3.9	2.5	0.5	8	7.9	920	62	71	0.649	0.656	0.652	WRS 2004
101	L49[j], L49[e]	260	NNW	31.1	0.067	5	1.8	3.7	0.8	20	6.6	172	45	145	0.291	0.358	0.361	WRS 2004
264	136[d]	260	N	5.2	0.003	26	6.3	2.2	1.2	-	8.0	1,836	-	-	-	0.331	0.329	OPTI/RAMP (OPTI Canada Inc. 2000)
263	134[d]	262	N	8.2	0.007	34	9.6	5.6	1.2	6	8.1	2,432	51	57	0.695	0.696	0.695	WRS 2004
260	131[d]	262	NNW	11.9	0.013	50	13.7	10.1	2.7	11	8.0	2,707	90	88	1.343	1.342	1.341	OPTI/RAMP (OPTI Canada Inc. 2000)
261	Ronald	263	NNW	346.1	0.564	43	12.2	14.3	3.4	13	8.0	2,737	99	98	1.946	1.945	1.942	WRS 2004
351	L68[j]	264	NNW	2.1	0.004	5	1.0	3.0	0.3	40	6.9	228	116	263	0.149	0.236	0.315	WRS 2004
352	L69[j]	264	NNW	2.4	0.004	33	6.0	8.0	0.8	28	8.0	2,180	217	190	1.317	1.303	1.787	WRS 2004
348	Currie	267	N	15.5	0.023	8	1.6	2.0	1.0	7	7.3	840	29	61	0.244	0.258	0.258	WRS 2004
95	29[f], L27[j]	267	NW	12.6	0.023	5	0.5	0.5	0.7	23	6.3	166	40	158	0.072	0.139	0.175	WRS 2004
350	Harwood	268	N	9.1	0.014	5	3.0	1.0	0.5	7	7.7	672	42	62	0.220	0.229	0.228	Meadow Creek Project (Petro Canada 2001)
349	Archer	273	N	42.9	0.087	4	2.0	1.0	0.4	10	7.8	502	66	81	0.209	0.219	0.218	Meadow Creek Project (Petro Canada 2001)
347	L64[j]	275	N	9.7	0.002	12	3.0	1.0	0.4	8	7.9	1,002	54	67	0.048	0.048	0.047	WRS 2004
96	28[f], L28[j], L28[e]	280	NNW	19.0	0.045	2	0.6	1.1	0.3	24	5.2	53	17	169	-0.013	0.100	0.096	WRS 2004
97	Clayton	283	NNW	13.1	0.033	1	0.2	0.8	0.1	16	4.3	0	5	120	-0.084	0.007	0.015	WRS 2004
529	Sandy [h]	304	N	452.7	0.624	17	9.2	6.1	1.2	-	7.3	–	–	–	–	0.797	0.797	WRS 2004
531	Cluff	309	NNE	219.0	1.256	15	8.9	1.7	0.7	-	8.1	–	–	–-	–	2.715	2.715	Kirby (Rio Alta 2002)

[a] Identifier used on map showing lake locations.

[b] Distance and direction relative to the MEG CLRP.

[c] Identifier used in the Water Quality Baseline Report for this study (Volume 4, Appendix 4-IV).

[d] Identifier used by previous EIAs, as described in the last column.

[e] Identifier used by RAMP (2004).

[f] Identifier used by Erickson (1987).

[g] Identifier used by Saffran and Trew (1996).

[h] Identifier used by Syncrude (2000).

[i] Identifier used by WRS (2004) for one hundred ponds sampled within Oil Sands Region during September 2000.

[j] Identifier used by WRS (2004) for a survey of 34 lakes conducted by Alberta-Pacific Forest Industries in 1999.

– = No data.

5.4 CRITICAL LOADS AND ACID INPUT RATES

Critical loads of acidity and acid input rates are provided in Table 15 for the 416 lakes included in the assessment. The assessment was based on critical loads adjusted for organic acids. Additionally, the assessment used lake net PAI, based on background rates calibrated to observed water quality and using a nitrogen deposition threshold of 75% of the first 10 kg/ha/yr. The results of the other two approaches for calculating acid inputs are provided for reference only in Table 15.

5.5 PREDICTED pH OF SNOWMELT

Predicted pH levels in snowmelt in the catchments of each of the 416 lakes are provided in Table 16. The predicted pH of snowmelt is somewhat lower than observed in precipitation at the Wood Buffalo Precipitation Monitoring Station in Fort McKay. The predicted pH calculation takes into account dry deposition throughout the winter and is therefore expected to be lower than the pH of precipitation. Snowmelt pH for the EAC is predicted to be 0.08 to 1.35 pH units lower than under background conditions, with differences less than 1 pH unit for most (95%) lake catchments. The snowmelt pH for the Project Case is predicted to range from less than 0.001 to 0.11 pH units below EAC values. The snowmelt pH for the PDC is predicted to range from a slight increase to 0.44 pH units below EAC values.

Table 15 Critical Loads of Acidity and Acid Input Rates for the 416 Lakes Included in the Assessment

Lake Identifier(a)	Lake Name/Original Identifier	Distance [km](b)	Direction(b)	pH	Critical Load of Acidity [keq/ha/yr]		Acid Input [keq/ha/yr]												Nitrogen Deposition [kg/ha/yr]			
							Based on All Acid Deposition				Based on Calibrated Background and No Nitrogen Threshold				Lake Net PAI (Based on Calibrated Background and a Nitrogen Threshold of 75% of the First 10 kg/ha/yr)							
					With Organic Acids	Without Organic Acids	AENV Background	EAC	Project Case	PDC	Calibrated Background	EAC	Project Case	PDC	Calibrated Background	EAC	Project Case	PDC	AENV Background	EAC	Project Case	PDC
618	Unnamed WB 9-04(c)	2	W	7.9	0.924	0.933	.	0.290	0.313	0.330	0.109	0.205	0.225	0.245	0.109	0.170	0.181	0.188	1.2	1.9	2.1	2.3
617	Unnamed WB 7-04(c)	3	WNW	7.6	0.494	0.517	0.186	0.283	0.302	0.322	0.020	0.114	0.130	0.150	0.020	0.080	0.088	0.095	1.2	1.9	2.0	2.3
616	Unnamed WB 8-04(c)	3	W	8.0	0.978	0.982	0.186	0.279	0.296	0.316	0.103	0.232	0.263	0.279	0.103	0.183	0.207	0.211	1.2	2.1	2.3	2.5
620	Unnamed WB 11-04(c)	4	E	8.0	0.722	0.725	0.186	0.315	0.347	0.362	0.017	0.127	0.151	0.169	0.017	0.085	0.100	0.106	1.2	2.0	2.2	2.4
609	Unnamed WB 2-07(c)	5	NE	8.1	1.066	1.040	0.186	0.296	0.320	0.337	0.031	0.120	0.133	0.153	0.031	0.088	0.094	0.101	1.2	1.8	2.0	2.2
614	Unnamed WB 15-04(c)	5	WSW	8.0	1.049	1.049	0.186	0.275	0.288	0.308	0.103	0.190	0.208	0.230	0.103	0.157	0.164	0.173	1.2	1.9	2.0	2.3
231	95(d), Unnamed WB 6-04(c)	7	N	7.6	0.697	0.728	0.186	0.273	0.290	0.313	0.028	0.115	0.132	0.154	0.028	0.081	0.088	0.097	1.2	1.9	2.0	2.3
615	Unnamed WB 5-04(c)	8	NNW	7.6	0.356	0.374	0.186	0.267	0.288	0.311	0.098	0.179	0.194	0.216	0.098	0.147	0.153	0.162	1.2	1.8	2.0	2.2
610	Unnamed WB 3-07(c)	8	W	7.8	0.443	0.451	0.186	0.266	0.282	0.303	0.012	0.115	0.142	0.151	0.012	0.081	0.092	0.091	1.2	1.9	2.2	2.4
621	Unnamed WB 13-04(c)	9	SE	8.8	1.406	1.348	0.186	0.288	0.316	0.325	0.107	0.200	0.208	0.232	0.107	0.170	0.173	0.182	1.2	1.8	1.9	2.2
2	Christina	9	SW	7.9	1.501	1.502	0.186	0.279	0.287	0.310	0.083	0.176	0.184	0.207	0.083	0.145	0.148	0.157	1.2	1.8	1.9	2.2
612	Unnamed WB 2-04(c)	9	W	7.8	0.585	0.593	0.186	0.265	0.281	0.303	0.098	0.183	0.226	0.249	0.098	0.148	0.160	0.170	1.2	1.9	2.5	2.7
613	Unnamed WB 16-04(c)	10	WNW	7.5	0.470	0.491	0.186	0.271	0.314	0.337	0.103	0.199	0.217	0.234	0.103	0.163	0.173	0.179	1.2	1.9	2.1	2.3
611	Unnamed WB 4-07(c)	10	ENE	7.8	0.551	0.555	0.186	0.281	0.299	0.317	0.015	0.095	0.109	0.134	0.015	0.064	0.069	0.079	1.2	1.8	2.0	2.2
147	94(d), 94(354)(e), Unnamed WB 1-07(c)	10	NNW	7.3	0.223	0.260	0.186	0.267	0.281	0.305	0.013	0.094	0.107	0.132	0.013	0.062	0.067	0.077	1.2	1.8	2.0	2.2
232	97(d), Unnamed WB 12-04(c)	11	E	7.8	1.093	1.107	0.186	0.278	0.303	0.318	0.020	0.113	0.137	0.152	0.020	0.079	0.090	0.094	1.2	1.9	2.1	2.3
233	98(d)	16	WSW	7.8	1.307	1.320	0.186	0.259	0.265	0.285	0.011	0.084	0.090	0.110	0.011	0.053	0.055	0.064	1.2	1.8	1.9	2.1
241	108(d)	21	SSW	8.2	2.318	2.299	0.218	0.308	0.313	0.344	0.011	0.101	0.106	0.137	0.011	0.071	0.073	0.090	1.4	2.0	2.1	2.3
240	Kirby	22	S	8.6	2.225	2.203	0.218	0.300	0.305	0.325	0.004	0.085	0.091	0.111	0.004	0.055	0.057	0.067	1.4	2.0	2.1	2.3
237	Winefred, WB-WL(c)	23	SE	8.4	2.202	2.172	0.213	0.283	0.289	0.298	0.034	0.104	0.110	0.120	0.034	0.085	0.088	0.091	1.4	1.8	1.8	2.0
230	93(d)	24	NE	7.9	1.387	1.387	0.182	0.262	0.268	0.290	0.014	0.093	0.100	0.121	0.014	0.063	0.066	0.075	1.2	1.8	1.8	2.1
227	Bohn	28	N	8.7	2.160	1.997	0.186	0.271	0.274	0.301	0.027	0.111	0.115	0.141	0.027	0.078	0.080	0.092	1.2	1.8	1.9	2.2
235	101(d)	31	E	8.3	1.696	1.633	0.182	0.253	0.261	0.278	0.096	0.167	0.176	0.192	0.096	0.141	0.144	0.151	1.2	1.7	1.8	2.0
234	100(d)	31	ENE	8.1	2.469	2.411	0.182	0.255	0.263	0.280	0.005	0.078	0.086	0.104	0.005	0.051	0.054	0.062	1.2	1.7	1.8	2.0
229	Cowper	31	NNE	9.1	1.917	1.684	0.182	0.262	0.267	0.290	0.020	0.100	0.104	0.127	0.020	0.070	0.071	0.082	1.2	1.8	1.8	2.1
228	90(d)	31	NNE	8.0	1.868	1.837	0.186	0.274	0.278	0.303	0.037	0.125	0.129	0.154	0.037	0.091	0.093	0.105	1.2	1.9	1.9	2.2
238	104(d)	34	SE	9.0	1.988	1.744	0.213	0.271	0.276	0.288	0.006	0.064	0.069	0.081	0.006	0.042	0.044	0.049	1.4	1.8	1.9	2.0
132	Grist	35	SSE	8.5	2.713	2.688	0.213	0.274	0.278	0.289	0.048	0.109	0.113	0.124	0.048	0.088	0.090	0.095	1.4	1.8	1.8	2.0
239	106(d)	36	SSE	8.3	1.170	1.159	0.218	0.284	0.288	0.301	0.002	0.068	0.072	0.086	0.002	0.040	0.042	0.048	1.4	2.0	2.0	2.1
139	91(d), 7(f)	39	NNE	9.2	1.874	1.621	0.182	0.266	0.270	0.294	0.035	0.119	0.123	0.147	0.035	0.088	0.089	0.100	1.2	1.8	1.8	2.1
186	40(d)	40	N	8.1	2.716	2.654	0.186	0.277	0.280	0.311	0.075	0.166	0.169	0.200	0.075	0.130	0.131	0.146	1.2	1.9	1.9	2.2
244	113(d)	40	SW	8.0	1.864	1.856	0.218	0.273	0.276	0.292	0.005	0.060	0.063	0.079	0.005	0.037	0.038	0.047	1.4	1.9	1.9	2.1
46	UNL4(g)	40	SSW	7.9	0.979	0.976	0.218	0.277	0.280	0.339	0.017	0.076	0.079	0.138	0.017	0.051	0.052	0.089	1.4	1.9	1.9	2.4
44	UNL1(g)	41	SW	8.0	1.665	1.654	0.218	0.271	0.274	0.290	0.056	0.109	0.112	0.128	0.056	0.088	0.089	0.097	1.4	1.8	1.9	2.0
236	102(d)	41	E	7.9	1.196	1.207	0.182	0.243	0.249	0.264	0.012	0.073	0.079	0.094	0.012	0.050	0.053	0.059	1.2	1.6	1.7	1.8
45	UNL3(g)	42	SSW	7.3	0.848	0.910	0.218	0.276	0.279	0.325	0.028	0.085	0.088	0.134	0.028	0.061	0.062	0.090	1.4	1.9	1.9	2.3
50	UNL13(g)	42	SW	6.5	0.199	0.331	0.218	0.270	0.273	0.288	0.060	0.112	0.114	0.130	0.060	0.091	0.092	0.099	1.4	1.8	1.9	2.0
49	UNL12(g)	42	SW	7.4	0.960	1.008	0.218	0.272	0.275	0.293	0.032	0.087	0.090	0.108	0.032	0.064	0.065	0.074	1.4	1.9	1.9	2.1
48	UNL7(g)	44	SW	7.4	0.827	0.879	0.218	0.271	0.273	0.290	0.032	0.084	0.087	0.103	0.032	0.062	0.063	0.071	1.4	1.9	1.9	2.0
47	UNL5(g)	44	SSW	7.7	1.110	1.134	0.218	0.272	0.275	0.295	0.024	0.078	0.081	0.102	0.024	0.055	0.056	0.067	1.4	1.9	1.9	2.1
43	Ipiatik	46	SSW	7.5	1.293	1.327	0.218	0.274	0.276	0.298	0.039	0.095	0.098	0.119	0.039	0.071	0.072	0.084	1.4	1.9	1.9	2.1
42	Wiau	47	SW	8.2	1.922	1.888	0.218	0.261	0.263	0.276	0.030	0.073	0.075	0.088	0.030	0.056	0.057	0.063	1.4	1.8	1.8	1.9
243	111(d)	49	WSW	7.7	1.121	1.150	0.218	0.260	0.263	0.275	0.009	0.051	0.054	0.066	0.009	0.035	0.036	0.041	1.4	1.8	1.8	1.9
222	81(d)	55	NW	7.6	1.001	1.045	0.186	0.238	0.240	0.263	0.006	0.059	0.060	0.084	0.006	0.039	0.039	0.049	1.2	1.6	1.6	1.9
167	Wappau	57	WSW	9.1	1.758	1.661	0.180	0.220	0.221	0.232	0.003	0.043	0.045	0.056	0.003	0.028	0.028	0.033	1.2	1.5	1.5	1.6
242	110(d)	58	WSW	8.3	0.976	0.952	0.222	0.262	0.264	0.275	0.007	0.047	0.049	0.059	0.007	0.031	0.032	0.037	1.5	1.8	1.8	1.9
245	114(d)	59	WSW	7.6	0.706	0.736	0.222	0.261	0.263	0.273	0.004	0.043	0.044	0.055	0.004	0.027	0.028	0.033	1.5	1.8	1.8	1.9
180	33(d)	60	NNW	6.6	0.197	0.327	0.186	0.298	0.300	0.338	0.018	0.131	0.132	0.170	0.018	0.083	0.084	0.102	1.2	2.1	2.1	2.5
184	Watchusk	61	NNE	8.6	2.021	1.897	0.182	0.264	0.265	0.292	0.017	0.099	0.101	0.127	0.017	0.068	0.069	0.082	1.2	1.8	1.8	2.1
130	32(d), 2(f)	62	NNW	7.7	1.370	1.402	0.186	0.298	0.299	0.340	0.039	0.151	0.152	0.193	0.039	0.106	0.107	0.127	1.2	2.1	2.1	2.5
136	34(d), 1(f)	63	NW	7.5	1.290	1.341	0.186	0.249	0.250	0.278	0.038	0.102	0.103	0.130	0.038	0.077	0.078	0.090	1.2	1.7	1.7	2.0
248	Clyde	63	SW	8.1	0.566	0.560	0.218	0.256	0.257	0.267	0.002	0.040	0.041	0.051	0.002	0.025	0.025	0.030	1.4	1.7	1.7	1.8
247	117(d)	63	SW	7.8	1.584	1.593	0.222	0.260	0.261	0.271	0.012	0.050	0.051	0.061	0.012	0.035	0.035	0.040	1.5	1.7	1.8	1.9
221	80(d)	64	WNW	7.3	0.284	0.322	0.180	0.227	0.228	0.264	0.003	0.050	0.051	0.087	0.003	0.032	0.032	0.045	1.2	1.5	1.5	2.0
145	28(d), 28(290)(e)	64	NNW	5.9	0.016	0.159	0.186	0.287	0.288	0.326	0.019	0.120	0.121	0.159	0.019	0.081	0.081	0.099	1.2	2.0	2.0	2.4

Table 15 Critical Loads of Acidity and Acid Input Rates for the 416 Lakes Included in the Assessment (continued)

Lake Identifier(a)	Lake Name/Original Identifier	Distance [km](b)	Direction(b)	pH	Critical Load of Acidity [keq/ha/yr]		Acid Input [keq/ha/yr]												Nitrogen Deposition [kg/ha/yr]			
							Based on All Acid Deposition				Based on Calibrated Background and No Nitrogen Threshold				Lake Net PAI (Based on Calibrated Background and a Nitrogen Threshold of 75% of the First 10 kg/ha/yr)							
					With Organic Acids	Without Organic Acids	AENV Background	EAC	Project Case	PDC	Calibrated Background	EAC	Project Case	PDC	Calibrated Background	EAC	Project Case	PDC	AENV Background	EAC	Project Case	PDC
178	30(d)	65	NNW	5.2	-0.095	0.030	0.186	0.288	0.289	0.327	0.020	0.122	0.123	0.161	0.020	0.082	0.082	0.101	1.2	2.0	2.0	2.4
181	35(d)	65	NNE	7.9	2.201	2.197	0.182	0.270	0.271	0.301	0.016	0.104	0.106	0.135	0.016	0.071	0.072	0.087	1.2	1.8	1.8	2.1
250	120(d)	65	SW	8.7	1.738	1.605	0.218	0.260	0.261	0.270	0.006	0.048	0.049	0.058	0.006	0.030	0.030	0.034	1.4	1.8	1.8	1.9
185	39(d)	66	NE	7.9	1.389	1.390	0.182	0.256	0.259	0.282	0.010	0.085	0.087	0.110	0.010	0.057	0.058	0.069	1.2	1.7	1.7	2.0
138	Goodwin	66	WSW	7.7	0.811	0.831	0.222	0.260	0.261	0.270	0.027	0.065	0.066	0.075	0.027	0.050	0.051	0.055	1.5	1.7	1.8	1.8
249	Behan	67	SW	8.2	0.493	0.483	0.222	0.258	0.260	0.268	0.002	0.038	0.039	0.048	0.002	0.024	0.024	0.028	1.5	1.7	1.7	1.8
176	20(d)	67	N	7.9	2.370	2.363	0.186	0.299	0.300	0.341	0.017	0.130	0.131	0.173	0.017	0.090	0.091	0.112	1.2	2.0	2.0	2.4
143	25(d), 25(287)(e)	67	NNW	5.2	-0.054	0.042	0.186	0.292	0.293	0.333	0.030	0.136	0.137	0.177	0.030	0.095	0.096	0.115	1.2	2.0	2.0	2.4
175	Georges	68	N	8.4	3.815	3.762	0.186	0.323	0.324	0.385	0.156	0.293	0.295	0.356	0.156	0.247	0.248	0.281	1.2	2.1	2.1	2.6
117	26(d), A26(e)	68	NNW	5.6	0.009	0.088	0.186	0.297	0.298	0.340	0.032	0.143	0.144	0.186	0.032	0.100	0.101	0.122	1.2	2.0	2.0	2.4
122	86(d), A86(e)	70	W	6.6	0.084	0.140	0.180	0.223	0.224	0.237	0.025	0.067	0.069	0.082	0.025	0.051	0.052	0.058	1.2	1.5	1.5	1.6
183	37(d)	70	NNE	8.5	1.678	1.640	0.182	0.257	0.259	0.282	0.007	0.082	0.084	0.107	0.007	0.054	0.055	0.067	1.2	1.7	1.7	2.0
177	22(d)	70	NNW	6.9	0.190	0.238	0.186	0.301	0.302	0.346	0.030	0.145	0.146	0.190	0.030	0.101	0.102	0.124	1.2	2.0	2.1	2.5
179	31(d)	70	NNW	5.6	-0.060	0.053	0.186	0.279	0.280	0.319	0.061	0.155	0.156	0.195	0.061	0.119	0.119	0.138	1.2	1.9	1.9	2.3
116	24(d), A24(e)	70	NNW	4.7	-0.103	0.046	0.186	0.290	0.291	0.331	0.027	0.131	0.132	0.173	0.027	0.092	0.092	0.112	1.2	2.0	2.0	2.4
218	77(d)	71	WNW	7.1	1.050	1.164	0.180	0.225	0.227	0.249	0.018	0.063	0.064	0.087	0.018	0.046	0.046	0.055	1.2	1.5	1.5	1.8
146	82(d), 82(342)(e)	71	WNW	6.8	0.127	0.198	0.180	0.225	0.226	0.243	0.010	0.055	0.056	0.072	0.010	0.038	0.038	0.045	1.2	1.5	1.5	1.7
131	Base	71	W	7.6	2.018	2.056	0.180	0.221	0.223	0.235	0.074	0.115	0.117	0.129	0.074	0.100	0.101	0.106	1.2	1.5	1.5	1.6
225	85(d)	71	W	7.2	0.233	0.280	0.180	0.223	0.224	0.238	0.011	0.054	0.056	0.070	0.011	0.038	0.039	0.045	1.2	1.5	1.5	1.7
144	27(d), 27(289)(e)	72	NW	6.5	0.033	0.100	0.186	0.275	0.276	0.316	0.015	0.104	0.105	0.145	0.015	0.070	0.070	0.089	1.2	1.9	1.9	2.3
220	79(d)	72	WNW	7.5	0.836	0.876	0.180	0.225	0.227	0.247	0.011	0.056	0.058	0.078	0.011	0.039	0.039	0.048	1.2	1.5	1.5	1.8
246	116(d)	73	WSW	7.7	0.686	0.708	0.222	0.261	0.262	0.271	0.023	0.062	0.063	0.071	0.023	0.046	0.046	0.050	1.5	1.8	1.8	1.9
38	L8(g)	74	NNW	6.8	0.614	0.727	0.186	0.315	0.316	0.366	0.143	0.273	0.274	0.324	0.143	0.223	0.223	0.249	1.2	2.2	2.2	2.6
115	21(d), A21(e)	74	NNW	5.0	-0.068	0.149	0.186	0.300	0.301	0.346	0.133	0.247	0.248	0.292	0.133	0.204	0.204	0.227	1.2	2.0	2.0	2.4
224	84(d)	75	W	7.1	0.237	0.285	0.180	0.221	0.223	0.236	0.012	0.053	0.054	0.068	0.012	0.037	0.038	0.044	1.2	1.5	1.5	1.6
251	Big Chief	76	SW	7.9	1.121	1.121	0.222	0.257	0.258	0.266	0.018	0.053	0.054	0.062	0.018	0.039	0.040	0.044	1.5	1.7	1.7	1.8
36	UNL3(g)	76	N	7.8	1.568	1.570	0.186	0.379	0.380	0.442	0.071	0.264	0.265	0.326	0.071	0.210	0.210	0.244	1.2	2.2	2.3	2.8
174	17(d)	76	NNW	7.4	0.866	0.924	0.186	0.319	0.320	0.368	0.041	0.173	0.174	0.223	0.041	0.123	0.124	0.149	1.2	2.2	2.2	2.6
118	29(d), A29(e)	76	NW	5.8	-0.005	0.082	0.180	0.249	0.250	0.282	0.018	0.087	0.088	0.119	0.018	0.061	0.061	0.077	1.2	1.7	1.7	2.0
37	Surmont	77	NNW	7.0	0.702	0.782	0.186	0.324	0.325	0.375	0.083	0.220	0.221	0.272	0.083	0.168	0.168	0.195	1.2	2.2	2.2	2.7
259	Logan	77	SSW	9.2	4.197	3.885	0.218	0.256	0.257	0.264	0.117	0.155	0.156	0.163	0.117	0.139	0.140	0.143	1.4	1.7	1.7	1.8
219	78(d)	78	WNW	7.3	1.142	1.201	0.180	0.224	0.226	0.243	0.022	0.067	0.068	0.086	0.022	0.049	0.050	0.058	1.2	1.5	1.5	1.7
182	Formby	78	NNE	8.1	1.825	1.812	0.182	0.250	0.252	0.272	0.006	0.074	0.075	0.096	0.006	0.050	0.051	0.061	1.2	1.6	1.7	1.8
258	128(d)	79	SW	8.5	4.001	3.876	0.218	0.254	0.255	0.263	0.066	0.103	0.104	0.111	0.066	0.088	0.089	0.092	1.4	1.7	1.7	1.8
27	Pushup	81	N	7.8	0.471	0.479	0.186	0.422	0.423	0.469	0.018	0.254	0.255	0.302	0.018	0.191	0.191	0.215	1.2	2.4	2.4	2.8
223	83(d)	81	WNW	7.9	1.344	1.354	0.180	0.222	0.223	0.238	0.014	0.056	0.057	0.072	0.014	0.040	0.040	0.047	1.2	1.5	1.5	1.7
110	Birch (d)	82	NNE	8.8	1.680	1.552	0.182	0.277	0.278	0.307	0.024	0.119	0.120	0.149	0.024	0.087	0.087	0.102	1.2	1.8	1.8	2.1
34	UNL1(g)	82	N	6.1	0.044	0.152	0.186	0.422	0.423	0.468	0.047	0.283	0.284	0.329	0.047	0.219	0.219	0.243	1.2	2.4	2.4	2.8
1	Birch (h)	83	N	7.7	1.779	1.797	0.186	0.445	0.445	0.489	0.306	0.564	0.565	0.609	0.306	0.496	0.496	0.519	1.2	2.5	2.5	2.9
39	L10(g)	83	NNW	5.8	0.019	0.064	0.186	0.327	0.328	0.383	0.084	0.226	0.227	0.282	0.084	0.174	0.175	0.204	1.2	2.2	2.2	2.7
31	Rat	83	N	7.8	2.103	2.112	0.186	0.442	0.443	0.486	0.095	0.351	0.352	0.394	0.095	0.280	0.281	0.303	1.2	2.5	2.6	2.9
40	L11(g)	84	NNW	6.0	0.084	0.195	0.186	0.329	0.330	0.386	0.133	0.276	0.277	0.333	0.133	0.224	0.225	0.254	1.2	2.2	2.2	2.7
26	Long (d)	84	N	7.2	0.617	0.673	0.186	0.412	0.413	0.456	0.085	0.311	0.312	0.355	0.085	0.248	0.248	0.271	1.2	2.4	2.4	2.8
28	Sucker	84	N	7.8	1.818	1.822	0.186	0.411	0.412	0.453	0.077	0.302	0.303	0.344	0.077	0.236	0.237	0.258	1.2	2.5	2.5	2.8
30	Poison	85	N	7.8	1.022	1.027	0.186	0.419	0.420	0.461	0.027	0.260	0.261	0.302	0.027	0.194	0.194	0.216	1.2	2.5	2.5	2.8
204	63(d)	85	WNW	7.5	0.875	0.920	0.180	0.224	0.225	0.241	0.010	0.054	0.055	0.071	0.010	0.036	0.037	0.043	1.2	1.5	1.5	1.7
41	Maqua	86	NNW	6.9	0.555	0.621	0.186	0.329	0.330	0.388	0.131	0.274	0.275	0.333	0.131	0.222	0.223	0.253	1.2	2.2	2.2	2.7
257	Heart	86	SW	8.9	4.064	3.898	0.222	0.255	0.256	0.263	0.078	0.112	0.113	0.119	0.078	0.099	0.099	0.102	1.5	1.7	1.7	1.8
29	Frog	86	N	7.7	1.980	2.001	0.186	0.390	0.391	0.431	0.069	0.273	0.274	0.314	0.069	0.211	0.212	0.232	1.2	2.4	2.4	2.8
173	Garson	87	NNE	8.1	1.456	1.439	0.182	0.249	0.250	0.269	0.011	0.077	0.078	0.097	0.011	0.055	0.056	0.066	1.2	1.6	1.6	1.8
226	88(d)	87	WNW	8.0	1.352	1.356	0.180	0.221	0.222	0.237	0.011	0.052	0.053	0.067	0.011	0.036	0.036	0.043	1.2	1.5	1.5	1.6
202	Mariana	88	WNW	7.2	1.214	1.257	0.180	0.223	0.224	0.239	0.065	0.108	0.110	0.124	0.065	0.091	0.091	0.098	1.2	1.5	1.5	1.7
171	Gipsy	88	NNE	8.5	0.629	0.626	0.182	0.264	0.265	0.289	0.002	0.084	0.085	0.108	0.002	0.056	0.057	0.069	1.2	1.7	1.7	1.9
35	PF12(i), UNL2(g)	88	NNW	6.2	0.477	0.598	0.186	0.353	0.354	0.393	0.068	0.235	0.236	0.275	0.068	0.178	0.179	0.199	1.2	2.3	2.3	2.6
207	66(d)	89	W	8.1	2.245	2.239	0.180	0.217	0.218	0.230	0.034	0.071	0.072	0.084	0.034	0.057	0.057	0.062	1.2	1.5	1.5	1.6

Table 15 Critical Loads of Acidity and Acid Input Rates for the 416 Lakes Included in the Assessment (continued)

Lake Identifier(a)	Lake Name/Original Identifier	Distance [km](b)	Direction(b)	pH	Critical Load of Acidity [keq/ha/yr]		Acid Input [keq/ha/yr]												Nitrogen Deposition [kg/ha/yr]			
							Based on All Acid Deposition				Based on Calibrated Background and No Nitrogen Threshold				Lake Net PAI (Based on Calibrated Background and a Nitrogen Threshold of 75% of the First 10 kg/ha/yr)							
					With Organic Acids	Without Organic Acids	AENV Background	EAC	Project Case	PDC	Calibrated Background	EAC	Project Case	PDC	Calibrated Background	EAC	Project Case	PDC	AENV Background	EAC	Project Case	PDC
33	Kiskatinaw	89	NNW	7.8	1.927	1.930	0.186	0.346	0.347	0.386	0.067	0.227	0.228	0.267	0.067	0.171	0.172	0.192	1.2	2.3	2.3	2.6
68	LK8(g)	90	SSE	7.8	0.645	0.649	0.213	0.325	0.326	0.334	0.112	0.224	0.226	0.233	0.112	0.172	0.172	0.176	1.4	2.4	2.4	2.5
515	Unnamed 5(g)	90	S	7.7	4.661	4.667	0.218	0.353	0.354	0.362	0.113	0.248	0.250	0.257	0.113	0.186	0.186	0.190	1.4	2.6	2.6	2.7
598	UN-5(g)	90	S	7.2	0.343	0.415	0.218	0.353	0.354	0.362	0.002	0.137	0.138	0.146	0.002	0.075	0.075	0.079	1.4	2.6	2.6	2.7
256	Piche	90	SW	8.7	4.273	4.184	0.222	0.255	0.256	0.262	0.085	0.118	0.119	0.125	0.085	0.105	0.106	0.109	1.5	1.7	1.7	1.8
25	Canoe	90	NNW	7.1	0.517	0.559	0.186	0.341	0.342	0.380	0.034	0.189	0.190	0.228	0.034	0.133	0.134	0.154	1.2	2.3	2.3	2.6
203	62(d)	90	WNW	6.9	0.742	0.825	0.180	0.227	0.228	0.243	0.057	0.104	0.105	0.120	0.057	0.083	0.084	0.091	1.2	1.6	1.6	1.7
597	UN-2(g)	91	S	7.9	2.278	2.278	0.218	0.325	0.326	0.333	0.002	0.109	0.110	0.117	0.002	0.061	0.061	0.064	1.4	2.3	2.4	2.4
253	123(d)	91	SW	8.7	3.408	3.357	0.222	0.253	0.254	0.261	0.041	0.073	0.074	0.080	0.041	0.061	0.061	0.064	1.5	1.7	1.7	1.8
170	Nora	91	N	9.1	1.110	0.942	0.186	0.292	0.293	0.324	0.002	0.109	0.109	0.140	0.002	0.070	0.070	0.086	1.2	1.9	2.0	2.2
205	Crow	92	W	8.8	3.107	2.971	0.180	0.218	0.219	0.232	0.092	0.130	0.131	0.143	0.092	0.115	0.115	0.121	1.2	1.5	1.5	1.6
463	PF9(i)	93	NNW	7.1	0.927	1.012	0.186	0.316	0.317	0.357	0.265	0.395	0.396	0.436	0.265	0.348	0.349	0.370	1.2	2.1	2.1	2.5
206	65(d)	93	W	8.5	3.145	3.051	0.180	0.216	0.217	0.228	0.092	0.127	0.128	0.140	0.092	0.113	0.114	0.119	1.2	1.5	1.5	1.6
254	124(d)	93	SW	9.5	2.099	1.810	0.222	0.253	0.253	0.260	0.009	0.039	0.040	0.047	0.009	0.028	0.028	0.031	1.5	1.7	1.7	1.8
67	LK7(g)	93	SSE	8.1	1.311	1.297	0.213	0.333	0.334	0.341	0.021	0.140	0.141	0.149	0.021	0.085	0.086	0.089	1.4	2.4	2.5	2.5
172	Baker	93	NNE	8.7	2.015	1.929	0.182	0.257	0.258	0.280	0.003	0.078	0.079	0.101	0.003	0.052	0.052	0.064	1.2	1.7	1.7	1.9
453	PF11(i)	93	NNW	6.1	0.236	0.424	0.186	0.328	0.329	0.366	0.066	0.208	0.209	0.246	0.066	0.156	0.156	0.176	1.2	2.2	2.2	2.5
3	Gregoire	93	NNW	7.4	1.130	1.162	0.186	0.318	0.318	0.356	0.163	0.295	0.295	0.333	0.163	0.247	0.247	0.268	1.2	2.1	2.1	2.4
252	122(d)	93	SW	7.9	0.822	0.827	0.222	0.254	0.254	0.260	0.014	0.045	0.046	0.052	0.014	0.033	0.033	0.036	1.5	1.7	1.7	1.8
109	Gordon	94	N	8.4	1.145	1.114	0.163	0.260	0.261	0.287	0.018	0.115	0.115	0.142	0.018	0.082	0.082	0.096	1.1	1.7	1.7	1.9
452	PF10(i)	94	NNW	6.9	0.556	0.650	0.186	0.324	0.325	0.362	0.140	0.278	0.279	0.316	0.140	0.227	0.227	0.247	1.2	2.2	2.2	2.5
599	UN-6(g)	95	S	6.8	0.653	0.748	0.218	0.356	0.358	0.365	0.007	0.145	0.146	0.153	0.007	0.083	0.083	0.086	1.4	2.6	2.6	2.7
66	LK6(g)	96	SSE	8.1	1.330	1.305	0.213	0.332	0.334	0.341	0.023	0.143	0.144	0.151	0.023	0.092	0.092	0.096	1.4	2.4	2.4	2.4
461	PF7(i)	96	NNW	7.5	2.240	2.288	0.186	0.318	0.318	0.359	0.221	0.353	0.353	0.394	0.221	0.304	0.305	0.326	1.2	2.1	2.1	2.5
169	Shortt	96	NNE	7.9	1.515	1.514	0.182	0.262	0.263	0.286	0.005	0.085	0.086	0.109	0.005	0.057	0.058	0.070	1.2	1.7	1.7	1.9
65	LK5(g)	97	SSE	7.8	0.709	0.713	0.213	0.341	0.342	0.349	0.024	0.153	0.154	0.161	0.024	0.098	0.099	0.102	1.4	2.4	2.4	2.5
32	Caribou Horn	97	N	7.7	1.721	1.737	0.163	0.291	0.292	0.326	0.130	0.258	0.259	0.293	0.130	0.207	0.208	0.225	1.1	2.0	2.0	2.3
64	LK4(g)	98	SSE	7.9	0.852	0.847	0.213	0.346	0.347	0.354	0.017	0.149	0.151	0.157	0.017	0.093	0.094	0.097	1.4	2.5	2.5	2.5
60	Burnt	98	S	8.1	2.852	2.838	0.213	0.343	0.345	0.351	0.071	0.201	0.202	0.209	0.071	0.146	0.146	0.150	1.4	2.4	2.5	2.5
255	125(d)	98	SW	8.5	4.047	3.889	0.222	0.251	0.252	0.258	0.074	0.103	0.104	0.110	0.074	0.092	0.092	0.095	1.5	1.7	1.7	1.7
63	LK3(g)	99	SSE	7.9	0.856	0.847	0.213	0.349	0.351	0.357	0.017	0.154	0.155	0.162	0.017	0.097	0.098	0.101	1.4	2.5	2.5	2.5
455	PF13(i)	99	N	7.7	2.042	2.062	0.163	0.291	0.292	0.326	0.087	0.216	0.217	0.251	0.087	0.165	0.165	0.183	1.1	2.0	2.0	2.3
62	LK2(g)	100	SSE	7.8	0.574	0.575	0.213	0.351	0.352	0.359	0.111	0.250	0.251	0.257	0.111	0.194	0.194	0.197	1.4	2.5	2.5	2.5
198	56(d)	101	WNW	7.1	0.747	0.866	0.180	0.227	0.228	0.243	0.029	0.077	0.077	0.092	0.029	0.058	0.058	0.066	1.2	1.5	1.5	1.7
61	LK1(g)	102	SSE	8.2	1.611	1.569	0.213	0.361	0.363	0.369	0.028	0.176	0.178	0.184	0.028	0.119	0.120	0.123	1.4	2.5	2.5	2.6
536	Touchwood	103	SSW	8.3	1.435	1.422	0.218	0.252	0.252	0.258	0.140	0.174	0.175	0.180	0.140	0.162	0.162	0.165	1.4	1.7	1.7	1.7
208	67(d)	104	W	7.3	1.015	1.094	0.180	0.212	0.212	0.222	0.107	0.138	0.139	0.149	0.107	0.126	0.126	0.131	1.2	1.4	1.4	1.5
168	8(d)	105	NNE	8.9	2.913	2.727	0.165	0.239	0.240	0.262	0.001	0.076	0.076	0.098	0.001	0.048	0.049	0.059	1.1	1.6	1.6	1.8
516	Sinclair (d)	105	S	8.3	2.683	2.663	0.218	0.309	0.310	0.316	0.088	0.179	0.180	0.186	0.088	0.144	0.144	0.147	1.4	2.1	2.1	2.2
199	57(d)	107	WNW	7.0	0.490	0.588	0.180	0.223	0.223	0.236	0.076	0.118	0.119	0.132	0.076	0.101	0.102	0.108	1.2	1.5	1.5	1.6
69	May	108	SSE	8.1	1.363	1.365	0.213	0.338	0.339	0.345	0.039	0.164	0.165	0.171	0.039	0.121	0.121	0.124	1.4	2.2	2.2	2.3
201	60(d)	108	WNW	7.5	1.131	1.191	0.180	0.217	0.217	0.229	0.038	0.075	0.075	0.087	0.038	0.060	0.060	0.066	1.2	1.5	1.5	1.6
538	Wolf	109	S	8.0	2.238	2.235	0.218	0.268	0.269	0.274	0.040	0.091	0.091	0.097	0.040	0.073	0.073	0.075	1.4	1.8	1.8	1.8
462	PF8(i)	110	NNW	7.4	1.790	1.846	0.163	0.307	0.308	0.343	0.378	0.522	0.522	0.558	0.378	0.467	0.467	0.485	1.1	2.1	2.1	2.4
517	Bourque	110	S	8.2	1.715	1.714	0.218	0.329	0.330	0.336	0.032	0.143	0.144	0.149	0.032	0.105	0.105	0.108	1.4	2.2	2.2	2.2
142	6(d), 6(271)(e)	113	NNE	9.0	1.315	1.040	0.165	0.250	0.251	0.275	0.006	0.091	0.091	0.116	0.006	0.059	0.059	0.071	1.1	1.7	1.7	1.9
209	Agnes (d)	114	W	6.5	0.292	0.453	0.195	0.226	0.227	0.237	0.032	0.064	0.064	0.074	0.032	0.051	0.051	0.056	1.3	1.5	1.5	1.6
196	54(d)	117	NW	7.2	0.556	0.633	0.180	0.238	0.239	0.256	0.056	0.114	0.115	0.132	0.056	0.091	0.091	0.099	1.2	1.6	1.6	1.8
530	La Loche	117	NE	8.1	0.941	0.941	0.182	0.236	0.237	0.251	0.182	0.236	0.237	0.251	0.182	0.221	0.221	0.229	1.2	1.5	1.5	1.6
518	Marguerite	117	S	8.8	1.178	1.108	0.218	0.283	0.284	0.289	0.001	0.067	0.067	0.072	0.001	0.044	0.044	0.046	1.4	1.9	1.9	1.9
519	Marie	118	SSE	8.1	1.155	1.155	0.213	0.320	0.321	0.326	0.026	0.133	0.134	0.139	0.026	0.110	0.110	0.113	1.4	1.8	1.8	1.9
459	PF5(i)	120	NNW	7.9	1.852	1.858	0.167	0.290	0.290	0.322	0.055	0.177	0.178	0.210	0.055	0.126	0.126	0.143	1.1	2.1	2.1	2.4
520	Leming	120	S	8.2	1.117	1.079	0.213	0.369	0.369	0.374	0.028	0.183	0.184	0.189	0.028	0.142	0.143	0.145	1.4	2.2	2.2	2.2
460	PF6(i)	120	NW	7.7	1.798	1.818	0.167	0.286	0.286	0.318	0.066	0.185	0.185	0.217	0.066	0.135	0.135	0.151	1.1	2.0	2.0	2.3
195	53(d)	121	NW	7.2	0.608	0.700	0.180	0.243	0.243	0.261	0.036	0.099	0.099	0.117	0.036	0.073	0.074	0.082	1.2	1.7	1.7	1.8

Table 15 Critical Loads of Acidity and Acid Input Rates for the 416 Lakes Included in the Assessment (continued)

Lake Identifier(a)	Lake Name/Original Identifier	Distance [km](b)	Direction(b)	pH	Critical Load of Acidity [keq/ha/yr]		Acid Input [keq/ha/yr]												Nitrogen Deposition [kg/ha/yr]			
							Based on All Acid Deposition				Based on Calibrated Background and No Nitrogen Threshold				Lake Net PAI (Based on Calibrated Background and a Nitrogen Threshold of 75% of the First 10 kg/ha/yr)							
					With Organic Acids	Without Organic Acids	AENV Background	EAC	Project Case	PDC	Calibrated Background	EAC	Project Case	PDC	Calibrated Background	EAC	Project Case	PDC	AENV Background	EAC	Project Case	PDC
540	Pinehurst	122	SSW	8.5	1.458	1.428	0.222	0.249	0.249	0.253	0.154	0.181	0.181	0.185	0.154	0.171	0.171	0.173	1.5	1.7	1.7	1.7
194	Algar	122	NW	7.5	0.529	0.564	0.180	0.241	0.241	0.259	0.114	0.175	0.175	0.192	0.114	0.150	0.150	0.159	1.2	1.6	1.7	1.8
537	La Biche	123	SW	8.6	-	2.181	0.222	0.244	0.244	0.248	0.106	0.128	0.128	0.132	0.106	0.120	0.121	0.123	1.5	1.6	1.6	1.7
141	4(d), 4(270)(e)	123	N	8.1	1.266	1.200	0.163	0.300	0.300	0.330	0.004	0.141	0.141	0.171	0.004	0.086	0.086	0.101	1.1	2.1	2.1	2.4
197	55(d)	124	WNW	7.1	0.622	0.718	0.180	0.233	0.234	0.249	0.074	0.127	0.127	0.143	0.074	0.105	0.105	0.113	1.2	1.6	1.6	1.7
600	Dolly	125	SSE	8.5	4.082	3.874	0.213	0.307	0.307	0.312	0.128	0.222	0.222	0.227	0.128	0.202	0.202	0.204	1.4	1.8	1.8	1.8
521	Tucker	126	S	8.1	2.291	2.283	0.218	0.287	0.287	0.292	0.059	0.128	0.128	0.133	0.059	0.106	0.106	0.108	1.4	1.9	1.9	1.9
533	McLean	128	NE	7.9	0.854	0.852	0.182	0.227	0.228	0.240	0.182	0.227	0.228	0.240	0.182	0.211	0.212	0.218	1.2	1.5	1.5	1.6
522	Ethel	128	S	8.3	1.124	1.117	0.213	0.319	0.319	0.323	0.029	0.135	0.135	0.140	0.029	0.109	0.109	0.112	1.4	1.9	1.9	1.9
523	Hilda	129	S	8.4	1.523	1.507	0.213	0.294	0.295	0.299	0.066	0.147	0.148	0.152	0.066	0.125	0.125	0.127	1.4	1.8	1.8	1.9
450	P99(i)	130	NNW	7.5	1.307	1.344	0.167	0.326	0.327	0.366	0.063	0.222	0.223	0.262	0.063	0.154	0.154	0.174	1.1	2.4	2.4	2.7
546	Cold	131	SSE	8.3	2.559	2.545	0.213	0.289	0.289	0.294	0.130	0.206	0.206	0.211	0.130	0.197	0.197	0.200	1.4	1.6	1.6	1.6
451	PF1(i)	131	NNW	7.9	3.194	3.201	0.167	0.300	0.300	0.333	0.089	0.222	0.222	0.256	0.089	0.165	0.166	0.182	1.1	2.2	2.2	2.5
456	PF2(i)	131	NNW	7.8	2.664	2.680	0.167	0.316	0.316	0.353	0.076	0.225	0.225	0.262	0.076	0.161	0.161	0.180	1.1	2.3	2.3	2.6
457	PF3(i)	131	NW	7.9	2.171	2.173	0.167	0.286	0.287	0.317	0.072	0.192	0.192	0.222	0.072	0.141	0.141	0.156	1.1	2.1	2.1	2.3
211	70(d)	131	W	7.3	0.564	0.645	0.195	0.226	0.227	0.236	0.051	0.082	0.083	0.092	0.051	0.070	0.070	0.074	1.3	1.5	1.5	1.6
458	PF4(i)	131	NNW	7.7	3.910	3.929	0.167	0.303	0.304	0.338	0.114	0.250	0.251	0.285	0.114	0.192	0.192	0.210	1.1	2.2	2.2	2.5
539	Field	132	SW	8.3	6.261	6.196	0.222	0.245	0.245	0.249	1.749	1.772	1.772	1.776	1.749	1.763	1.763	1.765	1.5	1.6	1.6	1.7
596	Manatokan	135	S	8.7	4.058	3.949	0.241	0.270	0.270	0.274	0.171	0.200	0.200	0.204	0.171	0.189	0.189	0.190	1.5	1.7	1.7	1.8
210	69(d)	135	W	6.7	0.245	0.359	0.195	0.223	0.223	0.232	0.025	0.053	0.053	0.061	0.025	0.042	0.042	0.046	1.3	1.5	1.5	1.6
129	2(d), 15(f), E15(L15b)(e)	137	N	7.0	0.463	0.586	0.163	0.318	0.318	0.352	0.014	0.169	0.170	0.203	0.014	0.109	0.109	0.125	1.1	2.2	2.2	2.5
135	3(d), 16(f)	137	NNE	8.7	1.584	1.449	0.165	0.238	0.239	0.259	0.031	0.104	0.105	0.125	0.031	0.079	0.079	0.089	1.1	1.6	1.6	1.8
121	59(d), A59(e)	137	WNW	5.2	0.023	0.245	0.195	0.226	0.227	0.236	0.043	0.074	0.075	0.084	0.043	0.062	0.062	0.066	1.3	1.5	1.5	1.6
405	P101(i)	138	NNW	7.5	1.161	1.204	0.167	0.340	0.341	0.383	0.089	0.263	0.263	0.305	0.089	0.188	0.188	0.209	1.1	2.5	2.5	2.9
212	71(d)	138	W	7.2	0.583	0.677	0.195	0.224	0.225	0.233	0.138	0.167	0.167	0.176	0.138	0.155	0.156	0.160	1.3	1.5	1.5	1.6
479	PTH12(i)	140	N	7.6	1.583	1.618	0.163	0.375	0.376	0.443	0.073	0.285	0.286	0.353	0.073	0.193	0.193	0.221	1.1	2.8	2.8	3.5
156	P98(i), P98(e)	141	NNW	7.3	0.918	1.001	0.167	0.390	0.390	0.443	0.054	0.278	0.278	0.330	0.054	0.179	0.180	0.206	1.1	2.9	2.9	3.4
214	73(d)	142	W	7.1	0.546	0.629	0.195	0.221	0.221	0.229	0.104	0.130	0.130	0.138	0.104	0.119	0.120	0.123	1.3	1.5	1.5	1.6
155	P97(i), P97(e)	142	NNW	6.8	0.302	0.418	0.167	0.430	0.431	0.492	0.031	0.294	0.295	0.356	0.031	0.177	0.178	0.208	1.1	3.3	3.3	3.9
213	72(d)	142	W	6.7	0.469	0.565	0.195	0.222	0.223	0.231	0.238	0.265	0.266	0.274	0.238	0.255	0.255	0.259	1.3	1.5	1.5	1.6
134	1(d), 25(f), 1(267)(e)	144	NNW	7.4	0.848	0.899	0.167	0.311	0.311	0.347	0.021	0.165	0.165	0.201	0.021	0.101	0.101	0.119	1.1	2.3	2.3	2.6
200	58(d)	145	WNW	6.5	0.248	0.401	0.195	0.225	0.225	0.234	0.019	0.049	0.050	0.058	0.019	0.037	0.038	0.042	1.3	1.5	1.5	1.6
154	P96(i), P96(e)	147	NNW	7.3	0.633	0.693	0.167	0.331	0.331	0.373	0.033	0.197	0.197	0.238	0.033	0.122	0.122	0.143	1.1	2.5	2.5	2.9
416	P30(i)	147	N	7.5	3.230	3.264	0.163	0.382	0.383	0.424	0.078	0.297	0.298	0.339	0.078	0.210	0.210	0.230	1.1	2.7	2.7	3.1
478	PTH11(i)	147	N	7.3	1.605	1.669	0.163	0.413	0.413	0.465	0.067	0.316	0.317	0.368	0.067	0.211	0.211	0.234	1.1	3.0	3.1	3.6
608	Suncor_VS_UW1	149	NNW	7.9	5.476	5.478	0.163	0.604	0.604	0.659	0.152	0.593	0.593	0.648	0.152	0.415	0.415	0.439	1.1	4.4	4.4	5.0
467	PM4(i)	149	N	7.6	1.867	1.906	0.163	0.383	0.383	0.423	0.078	0.298	0.298	0.338	0.078	0.213	0.213	0.232	1.1	2.7	2.7	3.1
215	Long (h)	149	W	7.5	1.035	1.080	0.195	0.220	0.221	0.228	0.110	0.136	0.136	0.143	0.110	0.126	0.126	0.129	1.3	1.5	1.5	1.6
425	P47(i)	150	N	7.8	1.856	1.853	0.163	0.385	0.385	0.425	0.087	0.309	0.310	0.350	0.087	0.223	0.223	0.242	1.1	2.7	2.7	3.1
58	Shipyard	151	NNW	7.6	3.473	3.501	0.163	0.979	0.979	0.973	0.110	0.925	0.926	0.920	0.110	0.503	0.503	0.512	1.1	9.0	9.0	8.7
449	P95(i)	152	NNW	7.5	2.249	2.304	0.167	0.330	0.330	0.373	0.137	0.300	0.301	0.344	0.137	0.222	0.222	0.243	1.1	2.6	2.6	3.0
424	P46(i)	152	N	8.3	2.576	2.427	0.163	0.397	0.398	0.438	0.072	0.307	0.307	0.347	0.072	0.213	0.213	0.233	1.1	2.8	2.8	3.2
140	L5(j), P28(i)	154	N	7.1	0.653	0.764	0.163	0.379	0.379	0.417	0.073	0.289	0.289	0.327	0.073	0.205	0.205	0.223	1.1	2.7	2.7	3.0
84	L8(j), L8(e)	154	N	7.0	0.584	0.679	0.163	0.321	0.321	0.354	0.041	0.199	0.199	0.232	0.041	0.141	0.141	0.157	1.1	2.2	2.2	2.5
216	75(d)	156	W	8.5	0.717	0.660	0.195	0.220	0.220	0.228	0.058	0.083	0.083	0.090	0.058	0.073	0.073	0.076	1.3	1.5	1.5	1.5
319	L6(j)	157	N	7.7	1.339	1.373	0.163	0.373	0.374	0.411	0.070	0.280	0.281	0.318	0.070	0.197	0.197	0.215	1.1	2.6	2.6	3.0
83	L7(j), L7(e)	159	N	6.4	0.187	0.401	0.163	0.360	0.360	0.396	0.114	0.311	0.311	0.347	0.114	0.233	0.234	0.251	1.1	2.5	2.5	2.9
217	Pelican	160	W	7.9	1.365	1.361	0.195	0.219	0.219	0.226	0.158	0.182	0.182	0.189	0.158	0.172	0.173	0.176	1.3	1.5	1.5	1.5
190	46(d)	161	WNW	6.5	0.189	0.330	0.195	0.232	0.232	0.243	0.016	0.053	0.053	0.064	0.016	0.038	0.038	0.043	1.3	1.6	1.6	1.7
161	49(d), A300(e)	164	WNW	7.1	0.105	0.135	0.195	0.229	0.230	0.240	0.001	0.036	0.036	0.046	0.001	0.022	0.022	0.027	1.3	1.5	1.5	1.6
191	48(d)	164	WNW	7.0	0.166	0.244	0.195	0.231	0.231	0.241	0.007	0.043	0.043	0.054	0.007	0.029	0.029	0.034	1.3	1.5	1.6	1.7
329	Mildred	164	NNW	8.2	2.494	2.491	0.167	0.902	0.902	0.991	0.451	1.186	1.186	1.275	0.451	0.805	0.806	0.852	1.1	8.2	8.2	9.0
422	P44(i)	164	N	9.0	4.044	3.250	0.163	0.313	0.314	0.347	0.105	0.255	0.255	0.289	0.105	0.197	0.197	0.213	1.1	2.2	2.2	2.5
120	47(d), A47(e)	165	WNW	6.4	0.187	0.289	0.195	0.231	0.231	0.241	0.062	0.098	0.098	0.109	0.062	0.084	0.084	0.089	1.3	1.5	1.6	1.7
150	P27(i), P27(e)	165	N	5.2	-0.019	0.254	0.163	0.389	0.390	0.431	0.027	0.254	0.254	0.295	0.027	0.159	0.159	0.179	1.1	2.8	2.8	3.2

Table 15 Critical Loads of Acidity and Acid Input Rates for the 416 Lakes Included in the Assessment (continued)

Lake Identifier(a)	Lake Name/Original Identifier	Distance [km](b)	Direction(b)	pH	Critical Load of Acidity [keq/ha/yr]		Acid Input [keq/ha/yr]												Nitrogen Deposition [kg/ha/yr]			
							Based on All Acid Deposition				Based on Calibrated Background and No Nitrogen Threshold				Lake Net PAI (Based on Calibrated Background and a Nitrogen Threshold of 75% of the First 10 kg/ha/yr)							
					With Organic Acids	Without Organic Acids	AENV Background	EAC	Project Case	PDC	Calibrated Background	EAC	Project Case	PDC	Calibrated Background	EAC	Project Case	PDC	AENV Background	EAC	Project Case	PDC
82	170(d), 14(f), L4(j), A170(L4)(e)	165	N	6.0	0.069	0.283	0.163	0.388	0.388	0.430	0.119	0.344	0.344	0.385	0.119	0.250	0.250	0.270	1.1	2.8	2.8	3.2
423	P45(i)	166	N	8.3	3.035	2.893	0.163	0.293	0.293	0.324	0.177	0.307	0.307	0.338	0.177	0.256	0.256	0.272	1.1	2.0	2.0	2.3
322	L15(j)	166	N	7.5	1.000	1.061	0.165	0.246	0.246	0.271	0.341	0.422	0.422	0.447	0.341	0.391	0.391	0.405	1.1	1.7	1.7	1.9
477	PTH10(i)	166	N	7.0	0.774	0.852	0.163	0.439	0.439	0.491	0.059	0.335	0.335	0.387	0.059	0.206	0.206	0.232	1.1	3.5	3.5	4.0
137	Wood Buffalo	167	WNW	6.9	0.772	0.891	0.195	0.233	0.233	0.244	0.140	0.177	0.178	0.188	0.140	0.163	0.163	0.168	1.3	1.6	1.6	1.7
535	Turnor	167	NE	7.3	0.430	0.445	0.164	0.202	0.203	0.212	0.164	0.202	0.203	0.212	0.164	0.190	0.191	0.196	1.1	1.3	1.3	1.4
485	PTH9(i)	167	N	7.4	0.841	0.879	0.163	0.442	0.442	0.495	0.076	0.355	0.355	0.408	0.076	0.223	0.223	0.250	1.1	3.5	3.5	4.0
314	Sandy (d)	169	W	8.1	1.543	1.528	0.195	0.217	0.217	0.224	0.241	0.263	0.264	0.270	0.241	0.255	0.255	0.258	1.3	1.5	1.5	1.5
193	50(d)	170	WNW	8.4	1.089	0.913	0.195	0.228	0.228	0.238	0.010	0.043	0.043	0.053	0.010	0.030	0.030	0.035	1.3	1.5	1.5	1.6
320	L9(j)	170	N	8.5	1.976	1.870	0.165	0.286	0.286	0.329	0.067	0.187	0.188	0.231	0.067	0.140	0.140	0.164	1.1	2.0	2.0	2.3
189	45(d)	171	WNW	8.6	1.602	1.384	0.195	0.230	0.231	0.241	0.018	0.053	0.054	0.063	0.018	0.039	0.039	0.044	1.3	1.5	1.6	1.6
119	42(d), A42(e)	172	WNW	6.8	0.402	0.561	0.195	0.232	0.232	0.242	0.021	0.057	0.058	0.068	0.021	0.043	0.043	0.048	1.3	1.6	1.6	1.7
414	P25(i)	172	N	7.7	1.548	1.573	0.163	0.428	0.428	0.471	0.062	0.327	0.328	0.370	0.062	0.216	0.216	0.237	1.1	3.1	3.2	3.6
445	P9(i)	172	N	7.8	1.976	1.979	0.163	0.323	0.323	0.358	0.067	0.227	0.227	0.261	0.067	0.161	0.161	0.178	1.1	2.3	2.3	2.6
188	44(d)	173	WNW	7.7	1.189	1.208	0.195	0.229	0.230	0.239	0.009	0.043	0.043	0.053	0.009	0.030	0.030	0.034	1.3	1.5	1.5	1.6
306	Horsetail	173	WNW	6.9	0.608	0.675	0.195	0.222	0.222	0.230	0.047	0.073	0.074	0.081	0.047	0.063	0.063	0.067	1.3	1.5	1.5	1.6
413	P24(i)	174	N	7.8	4.781	4.792	0.163	0.446	0.447	0.495	0.156	0.439	0.440	0.488	0.156	0.312	0.312	0.336	1.1	3.4	3.5	3.9
440	P8(i)	174	N	7.0	0.531	0.685	0.163	0.388	0.388	0.427	0.052	0.277	0.278	0.316	0.052	0.181	0.181	0.200	1.1	2.9	2.9	3.3
152	P7(i), P7(e)	174	N	6.4	0.151	0.307	0.163	0.396	0.397	0.436	0.016	0.250	0.250	0.289	0.016	0.150	0.150	0.168	1.1	2.9	2.9	3.3
606	P2	174	NNW	8.2	3.634	3.608	0.163	0.841	0.841	1.522	0.061	0.739	0.739	1.419	0.061	0.316	0.317	0.896	1.1	9.0	9.0	16.7
432	P6(i)	175	N	7.7	1.561	1.584	0.163	0.433	0.433	0.475	0.073	0.343	0.343	0.385	0.073	0.227	0.227	0.247	1.1	3.2	3.2	3.7
316	D254(h)	176	NW	8.4	2.275	2.167	0.175	0.216	0.217	0.228	0.085	0.126	0.126	0.137	0.085	0.109	0.109	0.114	1.2	1.5	1.5	1.6
421	P43(i)	177	N	7.5	0.883	0.929	0.163	0.448	0.449	0.491	0.071	0.357	0.357	0.400	0.071	0.232	0.232	0.252	1.1	3.4	3.4	3.8
318	L3(j)	178	N	7.8	-	1.186	0.163	0.463	0.463	0.515	0.070	0.369	0.370	0.421	0.070	0.225	0.225	0.249	1.1	3.8	3.8	4.3
149	P23(i), P23(e)	178	N	7.6	0.813	0.845	0.163	0.487	0.487	0.534	0.030	0.353	0.354	0.400	0.030	0.211	0.211	0.233	1.1	3.7	3.7	4.2
466	PM3(i)	178	N	7.4	1.038	1.100	0.163	0.468	0.469	0.519	0.056	0.361	0.362	0.412	0.056	0.220	0.220	0.243	1.1	3.7	3.7	4.2
465	PM2(i)	178	N	7.1	0.801	0.886	0.163	0.479	0.479	0.528	0.042	0.358	0.358	0.407	0.042	0.216	0.216	0.238	1.1	3.7	3.7	4.2
317	L2(j)	179	N	7.8	-	1.452	0.163	0.469	0.470	0.520	0.070	0.376	0.377	0.427	0.070	0.235	0.235	0.258	1.1	3.7	3.7	4.2
56	UW6(g)	179	NNW	8.0	1.480	1.471	0.167	1.077	1.078	1.903	0.103	1.013	1.013	1.838	0.103	0.489	0.489	1.314	1.1	12.3	12.3	21.3
464	PM1(i)	179	N	4.2	-0.273	-0.088	0.163	0.466	0.466	0.517	0.039	0.342	0.342	0.393	0.039	0.200	0.200	0.224	1.1	3.7	3.7	4.2
55	UW5(g)	179	NNW	8.2	2.192	2.175	0.163	1.013	1.013	1.573	0.068	0.918	0.918	1.478	0.068	0.395	0.395	0.955	1.1	11.5	11.5	17.5
605	P1	179	NNW	8.1	3.158	3.154	0.163	1.052	1.053	1.665	0.072	0.961	0.962	1.574	0.072	0.438	0.439	1.052	1.1	12.0	12.0	18.6
52	UW2(g)	179	NNW	8.1	1.533	1.533	0.167	1.069	1.069	1.706	0.048	0.950	0.951	1.588	0.048	0.427	0.428	1.065	1.1	12.2	12.2	19.1
53	UW3(g)	179	NNW	7.9	2.915	2.920	0.163	1.057	1.057	1.664	0.077	0.972	0.972	1.578	0.077	0.449	0.449	1.055	1.1	12.1	12.1	18.6
51	UW1(g)	179	NNW	8.0	2.920	2.919	0.167	1.071	1.071	1.695	0.076	0.980	0.980	1.604	0.076	0.457	0.457	1.081	1.1	12.2	12.2	18.9
607	P4	180	NNW	8.0	1.681	1.681	0.163	1.058	1.058	1.605	0.035	0.930	0.930	1.477	0.035	0.407	0.407	0.954	1.1	12.1	12.1	17.9
54	UW4(g)	180	NNW	8.2	2.949	2.930	0.163	1.057	1.057	1.582	0.064	0.958	0.958	1.483	0.064	0.435	0.435	0.959	1.1	12.1	12.1	17.7
88	168(d), 12(f), L14(j)	180	N	8.2	1.152	1.087	0.165	0.249	0.249	0.270	0.037	0.121	0.121	0.142	0.037	0.087	0.087	0.098	1.1	1.7	1.7	1.9
81	L1(j), L1(e)	181	N	6.3	0.183	0.208	0.163	0.455	0.455	0.509	0.076	0.368	0.368	0.421	0.076	0.226	0.226	0.251	1.1	3.7	3.7	4.3
532	unnamed	181	NE	7.0	1.307	1.380	0.164	0.207	0.207	0.218	0.164	0.207	0.207	0.218	0.164	0.191	0.192	0.197	1.1	1.4	1.4	1.5
87	167(d), L13(j)	181	N	7.5	0.650	0.684	0.165	0.251	0.251	0.272	0.030	0.116	0.116	0.137	0.030	0.081	0.081	0.092	1.1	1.7	1.7	1.9
447	P91(i)	182	NNW	7.7	3.144	3.163	0.167	0.273	0.273	0.305	0.144	0.249	0.249	0.282	0.144	0.191	0.192	0.206	1.1	2.2	2.2	2.5
153	P94(i), P94(e)	182	NNW	7.4	1.044	1.123	0.167	0.327	0.327	0.375	0.222	0.382	0.382	0.429	0.222	0.288	0.288	0.307	1.1	2.9	2.9	3.4
20	Isadore's	182	NNW	7.9	4.812	4.821	0.167	1.134	1.134	1.516	1.139	2.106	2.106	2.489	1.139	1.585	1.585	1.967	1.1	13.0	13.0	17.1
446	P90(i)	182	NNW	7.9	1.933	1.925	0.167	0.292	0.292	0.330	0.090	0.215	0.215	0.253	0.090	0.145	0.145	0.161	1.1	2.4	2.4	2.8
86	166(d), L12(j)	183	N	8.9	1.113	0.844	0.165	0.253	0.253	0.273	0.030	0.118	0.118	0.138	0.030	0.082	0.082	0.092	1.1	1.8	1.8	2.0
4	Kearl	184	N	8.0	1.534	1.521	0.163	0.754	0.754	0.755	0.079	0.670	0.670	0.672	0.079	0.290	0.290	0.308	1.1	8.2	8.2	7.9
187	41(d)	185	WNW	7.8	1.856	1.870	0.195	0.228	0.228	0.237	0.186	0.219	0.219	0.228	0.186	0.206	0.206	0.210	1.3	1.5	1.5	1.6
420	P4(i)	188	NNW	8.2	3.214	3.176	0.163	0.773	0.773	0.728	0.069	0.679	0.679	0.634	0.069	0.284	0.284	0.291	1.1	8.4	8.5	7.5
78	UNL-1(g)	191	N	8.2	5.019	4.992	0.163	0.677	0.677	1.642	0.088	0.602	0.602	1.567	0.088	0.275	0.275	1.048	1.1	7.2	7.2	20.3
304	D226(h)	192	WNW	8.2	1.324	1.294	0.175	0.205	0.206	0.214	0.496	0.527	0.527	0.535	0.496	0.514	0.515	0.519	1.2	1.4	1.4	1.5
415	P3(i)	195	N	7.8	2.745	2.752	0.163	0.623	0.623	1.403	0.090	0.549	0.549	1.330	0.090	0.259	0.259	0.811	1.1	6.5	6.5	17.1
79	UNL-2(g)	195	N	8.2	5.695	5.664	0.163	1.093	1.093	1.203	0.100	1.030	1.030	1.139	0.100	0.513	0.514	0.623	1.1	12.9	12.9	14.2
419	P38(i)	195	N	7.5	0.566	0.588	0.163	0.323	0.324	0.363	0.023	0.184	0.184	0.223	0.023	0.104	0.104	0.122	1.1	2.6	2.6	3.0
321	L11(j)	195	N	8.1	0.550	0.501	0.165	0.255	0.255	0.277	0.049	0.140	0.140	0.161	0.049	0.100	0.100	0.111	1.1	1.8	1.8	2.0

Table 15 Critical Loads of Acidity and Acid Input Rates for the 416 Lakes Included in the Assessment (continued)

Lake Identifier[a]	Lake Name/Original Identifier	Distance [km][b]	Direction[b]	pH	Critical Load of Acidity [keq/ha/yr]		Acid Input [keq/ha/yr]												Nitrogen Deposition [kg/ha/yr]			
							Based on All Acid Deposition				Based on Calibrated Background and No Nitrogen Threshold				Lake Net PAI (Based on Calibrated Background and a Nitrogen Threshold of 75% of the First 10 kg/ha/yr)							
					With Organic Acids	Without Organic Acids	AENV Background	EAC	Project Case	PDC	Calibrated Background	EAC	Project Case	PDC	Calibrated Background	EAC	Project Case	PDC	AENV Background	EAC	Project Case	PDC
284	Big Snuff	196	N	7.5	0.706	0.739	0.165	0.257	0.257	0.279	0.003	0.095	0.095	0.117	0.003	0.055	0.055	0.065	1.1	1.8	1.8	2.1
302	D223[h]	196	NW	9.3	1.681	1.235	0.175	0.208	0.208	0.217	0.261	0.294	0.294	0.303	0.261	0.280	0.280	0.285	1.2	1.4	1.4	1.5
411	P2[i]	197	N	8.3	2.352	2.315	0.163	0.573	0.573	0.969	0.152	0.562	0.562	0.958	0.152	0.306	0.306	0.439	1.1	5.8	5.8	11.0
80	P5[i], UNL-3[g]	197	N	7.9	2.362	2.367	0.163	0.662	0.662	0.763	0.048	0.546	0.547	0.648	0.048	0.226	0.226	0.264	1.1	7.1	7.1	8.2
373	22[f]	200	NW	7.7	-	2.545	0.175	0.207	0.208	0.216	0.471	0.503	0.504	0.512	0.471	0.490	0.490	0.494	1.2	1.4	1.4	1.5
85	164[d], 17[f], L10[j]	201	N	8.6	1.302	1.249	0.165	0.266	0.266	0.292	0.035	0.136	0.136	0.162	0.035	0.089	0.089	0.101	1.1	2.0	2.0	2.2
534	Proudfoot	202	NE	7.0	0.339	0.422	0.164	0.199	0.199	0.208	0.164	0.199	0.199	0.208	0.164	0.186	0.186	0.191	1.1	1.3	1.3	1.4
300	D221[h]	203	NW	8.6	0.267	0.257	0.175	0.209	0.209	0.218	0.014	0.048	0.048	0.057	0.014	0.034	0.034	0.038	1.2	1.4	1.4	1.5
19	Calumet	205	NNW	7.8	1.319	1.317	0.167	0.469	0.469	0.552	0.160	0.462	0.462	0.544	0.160	0.280	0.280	0.313	1.1	4.5	4.5	5.4
12	LK-7[g]	205	NNW	7.7	0.402	0.405	0.167	0.505	0.506	0.629	0.014	0.352	0.353	0.476	0.014	0.145	0.145	0.189	1.1	5.0	5.0	6.5
89	Rabbit	206	NW	8.4	2.650	2.476	0.175	0.215	0.215	0.225	0.258	0.298	0.298	0.309	0.258	0.282	0.282	0.287	1.2	1.5	1.5	1.6
488	PW3[i]	206	NNW	7.3	1.285	1.350	0.167	0.221	0.221	0.235	0.178	0.232	0.232	0.246	0.178	0.209	0.209	0.215	1.1	1.5	1.5	1.7
5	McClelland	206	N	8.3	1.508	1.491	0.163	0.469	0.469	0.561	0.064	0.370	0.371	0.463	0.064	0.188	0.188	0.232	1.1	4.5	4.5	5.4
283	163[d]	206	N	8.4	1.506	1.452	0.150	0.373	0.373	0.569	0.002	0.225	0.225	0.421	0.002	0.099	0.099	0.163	1.0	3.3	3.3	5.8
18	Lillian	206	NNW	7.6	0.776	0.781	0.167	0.485	0.485	0.698	0.011	0.329	0.329	0.542	0.011	0.135	0.135	0.200	1.1	4.7	4.7	7.5
406	P11[i]	207	NNW	7.4	1.505	1.586	0.167	0.234	0.234	0.252	0.202	0.269	0.269	0.287	0.202	0.239	0.239	0.247	1.1	1.7	1.7	1.9
336	L51[j]	207	NW	8.5	1.287	1.145	0.175	0.221	0.221	0.232	0.090	0.135	0.135	0.147	0.090	0.116	0.116	0.122	1.2	1.5	1.5	1.6
484	PTH8[i]	207	N	7.7	1.099	1.114	0.150	0.345	0.345	0.421	0.041	0.236	0.237	0.313	0.041	0.130	0.130	0.159	1.0	3.0	3.0	3.9
487	PW2[i]	207	NNW	7.9	3.230	3.209	0.167	0.227	0.227	0.243	0.334	0.395	0.395	0.410	0.334	0.367	0.368	0.375	1.1	1.6	1.6	1.8
301	D222[h]	207	NW	8.7	0.277	0.259	0.175	0.203	0.203	0.210	0.032	0.060	0.060	0.067	0.032	0.048	0.049	0.052	1.2	1.4	1.4	1.4
337	L52[j]	209	NW	7.4	1.249	1.297	0.175	0.219	0.219	0.231	0.356	0.400	0.400	0.411	0.356	0.381	0.381	0.387	1.2	1.5	1.5	1.6
418	P35[i]	209	N	8.1	1.050	1.027	0.150	0.341	0.341	0.425	0.032	0.223	0.223	0.307	0.032	0.118	0.118	0.149	1.0	2.9	2.9	3.9
407	P14[i]	210	NNW	7.6	2.331	2.376	0.167	0.223	0.223	0.238	0.617	0.673	0.673	0.687	0.617	0.648	0.648	0.655	1.1	1.6	1.6	1.7
282	162[d]	210	N	8.0	0.694	0.691	0.150	0.319	0.319	0.374	0.079	0.248	0.248	0.303	0.079	0.158	0.159	0.181	1.0	2.7	2.7	3.3
486	PW1[i]	210	NNW	7.2	1.762	1.877	0.167	0.219	0.219	0.233	0.659	0.712	0.712	0.725	0.659	0.689	0.689	0.695	1.1	1.5	1.5	1.7
483	PTH7[i]	210	N	8.0	1.944	1.922	0.150	0.333	0.333	0.404	0.068	0.250	0.251	0.322	0.068	0.151	0.151	0.178	1.0	2.8	2.8	3.7
443	P86[i]	210	NNW	7.7	4.696	4.720	0.167	0.216	0.216	0.229	1.342	1.391	1.391	1.404	1.342	1.370	1.370	1.376	1.1	1.5	1.5	1.6
148	P13[i], P13[e]	211	NNW	8.0	1.300	1.241	0.167	0.220	0.220	0.234	0.140	0.193	0.193	0.207	0.140	0.170	0.170	0.176	1.1	1.5	1.5	1.7
339	L54[j]	212	NW	7.6	4.639	4.681	0.175	0.216	0.216	0.227	1.121	1.162	1.162	1.172	1.121	1.145	1.145	1.150	1.2	1.5	1.5	1.6
338	L53[j]	213	NW	7.4	4.294	4.357	0.175	0.217	0.217	0.227	2.072	2.113	2.113	2.124	2.072	2.096	2.096	2.101	1.2	1.5	1.5	1.6
409	P17[i]	214	NNW	7.3	1.982	2.065	0.167	0.238	0.239	0.256	0.770	0.841	0.841	0.859	0.770	0.810	0.810	0.818	1.1	1.7	1.7	1.9
417	P34[i]	214	N	7.8	1.304	1.309	0.150	0.311	0.311	0.364	0.042	0.203	0.203	0.256	0.042	0.118	0.118	0.139	1.0	2.6	2.6	3.2
6	LK-1[g]	214	NNW	9.1	3.886	3.768	0.153	0.341	0.341	0.657	0.361	0.549	0.549	0.865	0.361	0.439	0.440	0.529	1.0	3.0	3.0	7.3
408	P16[i]	214	NNW	6.9	1.533	1.698	0.167	0.235	0.235	0.252	0.933	1.001	1.001	1.018	0.933	0.971	0.971	0.979	1.1	1.7	1.7	1.8
410	P18[i]	215	NNW	7.5	1.471	1.519	0.167	0.238	0.238	0.255	0.673	0.743	0.744	0.761	0.673	0.712	0.713	0.721	1.1	1.7	1.7	1.9
482	PTH6[i]	215	N	7.8	1.634	1.638	0.150	0.308	0.308	0.360	0.061	0.218	0.219	0.270	0.061	0.135	0.135	0.156	1.0	2.5	2.6	3.1
281	161[d]	216	N	8.5	1.063	1.031	0.150	0.263	0.263	0.293	0.079	0.192	0.192	0.222	0.079	0.137	0.137	0.150	1.0	2.0	2.0	2.3
102	33[f], L33[j]	217	NNW	8.4	1.843	1.805	0.167	0.226	0.226	0.241	0.255	0.314	0.314	0.329	0.255	0.288	0.288	0.295	1.1	1.6	1.6	1.7
526	Preston	218	NNE	6.8	0.595	0.642	0.164	0.202	0.202	0.211	0.164	0.202	0.202	0.211	0.164	0.189	0.189	0.193	1.1	1.3	1.3	1.4
481	PTH5[i]	218	N	8.0	2.030	2.020	0.150	0.302	0.302	0.356	0.050	0.201	0.201	0.256	0.050	0.120	0.120	0.142	1.0	2.5	2.5	3.1
475	PT9[i]	218	NNW	7.9	1.619	1.621	0.167	0.245	0.245	0.264	0.144	0.222	0.222	0.241	0.144	0.186	0.186	0.195	1.1	1.8	1.8	2.0
278	157[d]	218	N	8.3	2.586	2.540	0.150	0.313	0.313	0.386	0.003	0.166	0.166	0.240	0.003	0.077	0.077	0.104	1.0	2.7	2.7	3.5
280	160[d]	218	N	8.3	1.618	1.586	0.150	0.263	0.263	0.294	0.004	0.117	0.117	0.147	0.004	0.062	0.062	0.075	1.0	2.0	2.0	2.3
528	Lloyd	219	NNE	6.9	0.353	0.409	0.164	0.201	0.201	0.210	0.164	0.201	0.201	0.210	0.164	0.188	0.188	0.193	1.1	1.3	1.3	1.4
103	Audet	220	N	8.2	2.187	2.165	0.150	0.311	0.312	0.396	0.036	0.197	0.197	0.282	0.036	0.107	0.107	0.138	1.0	2.7	2.7	3.7
374	Carrot	221	NW	7.3	-	1.797	0.175	0.205	0.205	0.213	0.172	0.202	0.202	0.210	0.172	0.190	0.190	0.194	1.2	1.4	1.4	1.5
104	Johnson	222	N	8.4	2.082	2.049	0.144	0.235	0.235	0.258	0.031	0.122	0.122	0.145	0.031	0.080	0.080	0.090	1.0	1.7	1.7	2.0
279	158[d]	222	N	8.5	1.832	1.774	0.150	0.259	0.260	0.289	0.079	0.189	0.189	0.218	0.079	0.135	0.135	0.148	1.0	2.0	2.0	2.3
299	Chipewyan	222	NW	8.9	2.501	2.369	0.175	0.204	0.204	0.212	0.218	0.246	0.247	0.254	0.218	0.235	0.235	0.239	1.2	1.4	1.4	1.4
10	LK-5[g]	223	NNW	7.5	1.641	1.667	0.153	0.240	0.240	0.263	0.537	0.624	0.624	0.647	0.537	0.583	0.583	0.594	1.0	1.8	1.8	2.0
341	L56[j]	224	NW	7.2	1.124	1.217	0.175	0.210	0.210	0.219	0.233	0.268	0.268	0.276	0.233	0.254	0.255	0.259	1.2	1.4	1.4	1.5
444	P87[i]	224	NNW	7.3	1.158	1.246	0.153	0.206	0.206	0.218	0.124	0.176	0.177	0.189	0.124	0.154	0.154	0.160	1.0	1.4	1.4	1.5
442	P85[i]	224	NNW	7.2	1.100	1.220	0.167	0.216	0.216	0.228	0.207	0.256	0.256	0.268	0.207	0.236	0.236	0.241	1.1	1.5	1.5	1.6
17	LK-12[g]	224	NNW	7.2	1.313	1.370	0.153	0.239	0.239	0.262	0.527	0.613	0.613	0.636	0.527	0.572	0.572	0.583	1.0	1.8	1.8	2.0
340	L55[j]	225	NW	7.8	1.914	1.926	0.175	0.210	0.210	0.218	0.302	0.337	0.337	0.346	0.302	0.324	0.324	0.328	1.2	1.4	1.4	1.5

Table 15 Critical Loads of Acidity and Acid Input Rates for the 416 Lakes Included in the Assessment (continued)

Lake Identifier(a)	Lake Name/Original Identifier	Distance [km](b)	Direction(b)	pH	Critical Load of Acidity [keq/ha/yr]		Acid Input [keq/ha/yr]												Nitrogen Deposition [kg/ha/yr]			
							Based on All Acid Deposition				Based on Calibrated Background and No Nitrogen Threshold				Lake Net PAI (Based on Calibrated Background and a Nitrogen Threshold of 75% of the First 10 kg/ha/yr)							
					With Organic Acids	Without Organic Acids	AENV Background	EAC	Project Case	PDC	Calibrated Background	EAC	Project Case	PDC	Calibrated Background	EAC	Project Case	PDC	AENV Background	EAC	Project Case	PDC
441	P84(i)	226	NNW	7.1	1.028	1.133	0.167	0.210	0.211	0.221	0.119	0.162	0.162	0.173	0.119	0.144	0.144	0.149	1.1	1.4	1.4	1.5
11	LK-6(g)	226	NNW	7.5	1.613	1.643	0.153	0.233	0.233	0.254	0.489	0.569	0.569	0.590	0.489	0.532	0.532	0.542	1.0	1.7	1.7	1.9
474	PT8(i)	226	NNW	7.8	1.821	1.835	0.153	0.235	0.235	0.257	0.763	0.846	0.846	0.867	0.763	0.807	0.807	0.817	1.0	1.7	1.7	1.9
436	P70(i)	226	NNW	6.6	0.412	0.635	0.153	0.206	0.206	0.219	0.088	0.141	0.141	0.153	0.088	0.118	0.118	0.124	1.0	1.4	1.4	1.6
7	LK-2(g)	227	NNW	6.7	0.115	0.172	0.153	0.223	0.223	0.241	0.034	0.105	0.105	0.122	0.034	0.073	0.073	0.081	1.0	1.6	1.6	1.8
430	P52(i)	229	NNW	8.3	1.689	1.652	0.153	0.259	0.259	0.291	0.375	0.480	0.481	0.512	0.375	0.424	0.424	0.438	1.0	2.1	2.1	2.4
473	PT6(i)	229	NNW	8.4	1.354	1.301	0.153	0.256	0.256	0.287	0.198	0.301	0.302	0.332	0.198	0.247	0.247	0.261	1.0	2.0	2.0	2.3
91	Namur	230	NNW	7.2	0.222	0.242	0.175	0.212	0.212	0.220	0.068	0.104	0.104	0.113	0.068	0.090	0.090	0.094	1.2	1.4	1.4	1.5
426	P48(i)	230	NNW	7.7	1.688	1.716	0.153	0.234	0.234	0.256	0.457	0.537	0.538	0.559	0.457	0.500	0.500	0.510	1.0	1.7	1.7	1.9
525	Forrest	232	NNE	6.9	0.533	0.574	0.150	0.186	0.187	0.195	0.150	0.186	0.187	0.195	0.150	0.173	0.174	0.178	1.0	1.2	1.2	1.3
323	S. Gardiner	232	NNW	7.6	0.905	0.926	0.153	0.191	0.191	0.200	0.109	0.147	0.147	0.156	0.109	0.132	0.132	0.137	1.0	1.3	1.3	1.4
277	153(d)	232	N	8.7	0.868	0.777	0.150	0.260	0.260	0.298	0.079	0.189	0.189	0.227	0.079	0.131	0.131	0.147	1.0	2.1	2.1	2.5
346	Canopener	232	NNW	7.6	0.905	0.921	0.153	0.196	0.196	0.206	0.019	0.062	0.062	0.072	0.019	0.045	0.045	0.050	1.0	1.3	1.3	1.4
345	Buoy	233	NNW	8.3	1.730	1.703	0.153	0.194	0.195	0.204	0.103	0.144	0.144	0.154	0.103	0.128	0.128	0.132	1.0	1.3	1.3	1.4
524	Patterson	235	NNE	6.9	0.370	0.412	0.150	0.187	0.188	0.196	0.150	0.187	0.188	0.196	0.150	0.174	0.174	0.179	1.0	1.2	1.2	1.3
428	P50(i)	235	NNW	8.2	4.024	3.974	0.153	0.220	0.220	0.236	0.264	0.331	0.332	0.348	0.264	0.302	0.302	0.310	1.0	1.6	1.6	1.7
434	P61(i)	235	NNW	7.5	1.200	1.269	0.153	0.197	0.197	0.207	0.107	0.150	0.151	0.161	0.107	0.133	0.133	0.138	1.0	1.3	1.3	1.4
429	P51(i)	235	NNW	7.3	1.359	1.416	0.153	0.229	0.229	0.249	0.649	0.725	0.725	0.745	0.649	0.690	0.690	0.699	1.0	1.7	1.7	1.9
324	N. Gardiner	235	NNW	7.8	0.926	0.939	0.153	0.190	0.190	0.199	0.106	0.143	0.143	0.152	0.106	0.128	0.128	0.132	1.0	1.3	1.3	1.4
412	P20(i)	236	NNW	7.5	0.995	1.064	0.153	0.210	0.210	0.223	0.113	0.170	0.170	0.184	0.113	0.146	0.146	0.152	1.0	1.5	1.5	1.6
431	P54(i)	236	NNW	7.8	0.918	0.935	0.153	0.226	0.226	0.245	0.219	0.292	0.292	0.312	0.219	0.259	0.259	0.268	1.0	1.6	1.6	1.8
472	PT5(i)	236	NNW	7.5	0.815	0.879	0.153	0.223	0.224	0.242	0.074	0.144	0.144	0.162	0.074	0.112	0.112	0.121	1.0	1.6	1.6	1.8
435	P69(i)	237	NNW	7.4	0.940	1.040	0.153	0.197	0.197	0.208	0.079	0.124	0.124	0.134	0.079	0.106	0.106	0.111	1.0	1.3	1.3	1.4
438	P77(i)	237	NNW	7.1	0.878	1.018	0.153	0.208	0.208	0.221	0.102	0.156	0.156	0.170	0.102	0.133	0.133	0.139	1.0	1.4	1.4	1.6
439	P79(i)	237	NNW	7.0	0.848	1.018	0.153	0.208	0.208	0.222	0.108	0.163	0.163	0.177	0.108	0.140	0.140	0.146	1.0	1.4	1.4	1.6
471	PT4(i)	237	NNW	7.6	1.211	1.267	0.153	0.207	0.207	0.221	0.115	0.169	0.169	0.182	0.115	0.146	0.146	0.152	1.0	1.4	1.4	1.6
151	P49(i), P49(e)	237	NNW	6.7	0.234	0.363	0.153	0.218	0.219	0.234	0.051	0.117	0.117	0.133	0.051	0.088	0.088	0.096	1.0	1.5	1.5	1.7
93	Legend	237	NW	6.9	0.076	0.106	0.175	0.204	0.204	0.211	0.035	0.064	0.064	0.071	0.035	0.053	0.053	0.056	1.2	1.4	1.4	1.4
470	PT3(i)	240	NNW	7.5	1.130	1.209	0.153	0.200	0.201	0.212	0.140	0.188	0.188	0.199	0.140	0.168	0.168	0.174	1.0	1.4	1.4	1.5
527	Beet	241	NNE	6.9	0.571	0.622	0.150	0.184	0.185	0.193	0.150	0.184	0.185	0.193	0.150	0.172	0.172	0.177	1.0	1.2	1.2	1.3
325	L21(j)	242	NNW	7.9	0.345	0.353	0.153	0.189	0.189	0.197	0.076	0.113	0.113	0.121	0.076	0.099	0.099	0.103	1.0	1.3	1.3	1.3
326	Sand	243	NNW	8.0	0.894	0.885	0.153	0.192	0.192	0.200	0.044	0.082	0.082	0.091	0.044	0.068	0.068	0.072	1.0	1.3	1.3	1.4
433	P60(i)	243	NNW	7.7	1.996	2.029	0.153	0.201	0.201	0.212	0.175	0.223	0.223	0.234	0.175	0.203	0.203	0.209	1.0	1.4	1.4	1.5
333	L45(j)	244	N	8.0	0.881	0.883	0.150	0.234	0.234	0.260	0.031	0.115	0.115	0.141	0.031	0.069	0.069	0.080	1.0	1.9	1.9	2.1
334	L48(j)	244	NNW	7.4	0.934	0.982	0.153	0.195	0.195	0.205	0.027	0.069	0.069	0.078	0.027	0.052	0.052	0.057	1.0	1.3	1.3	1.4
328	Clear	245	NNW	7.4	0.779	0.824	0.153	0.196	0.196	0.206	0.047	0.090	0.090	0.100	0.047	0.073	0.073	0.078	1.0	1.3	1.3	1.4
468	PT1(i)	246	NNW	8.0	1.356	1.336	0.153	0.194	0.194	0.204	0.173	0.214	0.214	0.224	0.173	0.198	0.198	0.203	1.0	1.3	1.3	1.4
476	PTH1(i)	247	N	8.3	1.023	1.013	0.150	0.223	0.223	0.247	0.055	0.127	0.128	0.151	0.055	0.089	0.089	0.100	1.0	1.7	1.7	2.0
437	P72(i)	248	NNW	5.9	0.484	0.760	0.153	0.193	0.193	0.202	0.447	0.486	0.487	0.496	0.447	0.471	0.471	0.475	1.0	1.3	1.3	1.4
469	PT2(i)	249	NNW	5.0	0.231	0.505	0.153	0.193	0.193	0.202	0.385	0.425	0.425	0.434	0.385	0.410	0.410	0.414	1.0	1.3	1.3	1.4
271	145(d)	249	N	8.4	-	1.123	0.150	0.218	0.219	0.241	0.018	0.087	0.087	0.109	0.018	0.051	0.051	0.061	1.0	1.7	1.7	1.9
108	Waterlily	249	NNW	7.7	0.717	0.735	0.153	0.187	0.188	0.195	0.213	0.247	0.247	0.255	0.213	0.234	0.235	0.238	1.0	1.2	1.2	1.3
92	Otasan	249	NNW	6.7	0.071	0.107	0.153	0.190	0.190	0.198	0.017	0.053	0.053	0.062	0.017	0.040	0.040	0.044	1.0	1.3	1.3	1.3
344	L59(j)	249	NNW	7.3	0.336	0.397	0.160	0.191	0.191	0.197	0.068	0.099	0.099	0.106	0.068	0.087	0.088	0.091	1.1	1.3	1.3	1.3
343	L58(j)	250	NW	9.3	0.817	0.608	0.175	0.201	0.201	0.207	0.020	0.046	0.046	0.052	0.020	0.036	0.036	0.039	1.2	1.3	1.3	1.4
275	151(d)	250	N	7.2	0.315	0.361	0.144	0.198	0.199	0.213	0.018	0.073	0.073	0.088	0.018	0.047	0.047	0.053	1.0	1.4	1.4	1.6
107	L60(j), L60(e)	251	NNW	7.2	0.409	0.459	0.160	0.193	0.193	0.201	0.156	0.189	0.190	0.197	0.156	0.177	0.177	0.181	1.1	1.3	1.3	1.4
480	PTH2(i)	251	N	8.1	1.305	1.303	0.150	0.215	0.215	0.235	0.059	0.124	0.124	0.145	0.059	0.091	0.091	0.100	1.0	1.6	1.6	1.8
342	L57(j)	251	NW	7.7	1.109	1.119	0.175	0.200	0.200	0.206	0.085	0.110	0.110	0.116	0.085	0.101	0.101	0.104	1.2	1.3	1.3	1.4
327	Eaglenest	251	NNW	7.5	0.652	0.682	0.153	0.192	0.192	0.201	0.040	0.079	0.079	0.088	0.040	0.063	0.063	0.067	1.0	1.3	1.3	1.4
270	143(d)	251	N	8.1	-	0.877	0.150	0.215	0.216	0.236	0.020	0.085	0.086	0.106	0.020	0.050	0.050	0.059	1.0	1.7	1.7	1.9
99	144(d), L43(j)	251	N	8.1	1.032	1.042	0.150	0.215	0.215	0.236	0.029	0.094	0.094	0.115	0.029	0.059	0.059	0.068	1.0	1.6	1.7	1.9
332	L44(j)	251	N	8.7	0.101	0.098	0.150	0.216	0.216	0.236	0.003	0.069	0.069	0.089	0.003	0.033	0.033	0.042	1.0	1.7	1.7	1.9
274	149(d)	251	N	8.3	1.385	1.382	0.150	0.212	0.212	0.231	0.010	0.072	0.072	0.091	0.010	0.041	0.041	0.049	1.0	1.6	1.6	1.8
276	152(d)	252	N	8.3	-	0.792	0.150	0.211	0.211	0.230	0.005	0.066	0.066	0.085	0.005	0.035	0.035	0.044	1.0	1.6	1.6	1.8

Table 15 Critical Loads of Acidity and Acid Input Rates for the 416 Lakes Included in the Assessment (continued)

Lake Identifier(a)	Lake Name/Original Identifier	Distance [km](b)	Direction(b)	pH	Critical Load of Acidity [keq/ha/yr]		Acid Input [keq/ha/yr]												Nitrogen Deposition [kg/ha/yr]			
							Based on All Acid Deposition				Based on Calibrated Background and No Nitrogen Threshold				Lake Net PAI (Based on Calibrated Background and a Nitrogen Threshold of 75% of the First 10 kg/ha/yr)							
					With Organic Acids	Without Organic Acids	AENV Background	EAC	Project Case	PDC	Calibrated Background	EAC	Project Case	PDC	Calibrated Background	EAC	Project Case	PDC	AENV Background	EAC	Project Case	PDC
273	148(d)	253	N	8.2	-	0.813	0.150	0.210	0.210	0.228	0.005	0.064	0.065	0.083	0.005	0.035	0.035	0.043	1.0	1.6	1.6	1.7
98	146(d), L40(j)	253	N	8.0	0.093	0.094	0.150	0.210	0.210	0.228	0.003	0.063	0.063	0.081	0.003	0.032	0.032	0.041	1.0	1.6	1.6	1.7
330	L41(j)	254	N	7.8	0.604	0.609	0.150	0.210	0.210	0.229	0.050	0.110	0.110	0.129	0.050	0.078	0.078	0.087	1.0	1.6	1.6	1.8
105	150(d), 9(f), L39(j), A-150(L39)(e)	256	N	6.8	0.177	0.233	0.144	0.197	0.197	0.212	0.035	0.088	0.089	0.104	0.035	0.063	0.063	0.069	1.0	1.4	1.4	1.6
106	Bayard	256	NNW	6.7	0.424	0.510	0.153	0.188	0.188	0.195	0.205	0.239	0.239	0.247	0.205	0.227	0.227	0.230	1.0	1.2	1.2	1.3
269	142(d)	256	N	8.3	1.507	1.501	0.150	0.207	0.208	0.226	0.021	0.079	0.079	0.097	0.021	0.049	0.049	0.057	1.0	1.6	1.6	1.7
268	141(d)	256	N	8.3	-	1.153	0.150	0.208	0.208	0.226	0.015	0.073	0.073	0.091	0.015	0.042	0.042	0.051	1.0	1.6	1.6	1.7
262	Dianne	256	NNW	7.9	1.711	1.712	0.153	0.206	0.206	0.222	0.321	0.374	0.374	0.389	0.321	0.347	0.347	0.354	1.0	1.5	1.5	1.7
100	27(f), L47(j), L47(e)	257	NNW	6.7	0.371	0.430	0.160	0.191	0.191	0.198	0.133	0.164	0.164	0.170	0.133	0.152	0.152	0.156	1.1	1.3	1.3	1.3
335	L50(j)	258	NNW	7.0	0.391	0.455	0.160	0.190	0.190	0.196	0.141	0.171	0.171	0.177	0.141	0.160	0.160	0.163	1.1	1.3	1.3	1.3
267	139(d)	258	N	8.1	0.428	0.430	0.150	0.207	0.207	0.224	0.005	0.062	0.062	0.079	0.005	0.032	0.032	0.040	1.0	1.6	1.6	1.7
265	Pearson	258	N	8.1	-	0.432	0.150	0.211	0.211	0.229	0.007	0.068	0.068	0.086	0.007	0.035	0.035	0.043	1.0	1.6	1.6	1.8
331	L42(j)	259	N	8.1	0.876	0.879	0.150	0.205	0.205	0.222	0.025	0.080	0.080	0.097	0.025	0.051	0.051	0.059	1.0	1.5	1.5	1.7
272	Poplar	259	N	8.4	1.690	1.676	0.150	0.204	0.204	0.220	0.017	0.071	0.071	0.087	0.017	0.044	0.044	0.052	1.0	1.5	1.5	1.7
266	Kress	259	N	7.9	0.649	0.656	0.150	0.207	0.207	0.224	0.001	0.059	0.059	0.076	0.001	0.028	0.028	0.036	1.0	1.6	1.6	1.7
101	L49(j), L49(e)	260	NNW	6.6	0.291	0.358	0.160	0.193	0.193	0.200	0.211	0.243	0.243	0.250	0.211	0.232	0.232	0.235	1.1	1.3	1.3	1.3
264	136(d)	260	N	8.0	-	0.331	0.150	0.208	0.209	0.226	0.001	0.059	0.059	0.077	0.001	0.028	0.028	0.036	1.0	1.6	1.6	1.8
263	134(d)	262	N	8.1	0.695	0.696	0.153	0.203	0.203	0.218	0.081	0.131	0.131	0.146	0.081	0.105	0.106	0.112	1.0	1.5	1.5	1.6
260	131(d)	262	NNW	8.0	1.343	1.342	0.153	0.196	0.196	0.208	0.388	0.431	0.431	0.443	0.388	0.410	0.410	0.416	1.0	1.4	1.4	1.5
261	Ronald	263	NNW	8.0	1.946	1.945	0.153	0.197	0.197	0.209	0.366	0.410	0.410	0.422	0.366	0.388	0.388	0.394	1.0	1.4	1.4	1.5
351	L68(j)	264	NNW	6.9	0.149	0.236	0.153	0.185	0.185	0.192	0.075	0.107	0.107	0.114	0.075	0.095	0.095	0.098	1.0	1.2	1.2	1.3
352	L69(j)	264	NNW	8.0	1.317	1.303	0.153	0.184	0.184	0.191	0.111	0.143	0.143	0.150	0.111	0.131	0.131	0.134	1.0	1.2	1.2	1.3
348	Currie	267	N	7.3	0.244	0.258	0.150	0.197	0.197	0.212	0.014	0.062	0.062	0.076	0.014	0.038	0.038	0.045	1.0	1.4	1.4	1.6
95	29(f), L27(j)	267	NW	6.3	0.072	0.139	0.160	0.184	0.184	0.189	0.051	0.075	0.075	0.080	0.051	0.067	0.067	0.069	1.1	1.2	1.2	1.3
350	Harwood	268	N	7.7	0.220	0.229	0.144	0.192	0.193	0.207	0.015	0.063	0.064	0.078	0.015	0.040	0.040	0.046	1.0	1.4	1.4	1.5
349	Archer	273	N	7.8	0.209	0.219	0.144	0.191	0.191	0.204	0.021	0.067	0.067	0.081	0.021	0.044	0.044	0.050	1.0	1.4	1.4	1.5
347	L64(j)	275	N	7.9	0.048	0.048	0.150	0.193	0.193	0.206	0.002	0.045	0.045	0.058	0.002	0.023	0.023	0.029	1.0	1.4	1.4	1.5
96	28(f), L28(j), L28(e)	280	NNW	5.2	-0.013	0.100	0.160	0.188	0.188	0.194	0.036	0.063	0.064	0.069	0.036	0.054	0.054	0.056	1.1	1.2	1.2	1.3
97	Clayton	283	NNW	4.3	-0.084	0.007	0.153	0.178	0.178	0.183	0.010	0.035	0.035	0.041	0.010	0.025	0.025	0.028	1.0	1.2	1.2	1.2
529	Sandy (h)	304	N	7.3	–	0.797	0.144	0.173	0.173	0.180	0.144	0.173	0.173	0.180	0.144	0.159	0.159	0.162	1.0	1.2	1.2	1.3
531	Cluff	309	NNE	8.1	–	2.715	0.150	0.173	0.173	0.180	0.150	0.173	0.173	0.180	0.150	0.163	0.163	0.165	1.0	1.2	1.2	1.3

(a) Identifier used on map showing lake locations.

(b) Distance and direction relative to the MEG CLRP.

(c) Identifier used in the Water Quality Baseline Report for this study (Volume 4, Appendix 4-IV).

(d) Identifier used by previous EIAs, refer to Section 5.3.

(e) Identifier used by RAMP (2004).

(f) Identifier used by Erickson (1987).

(g) Identifier used by Saffran and Trew (1996).

(h) Identifier used by Syncrude (2000).

(i) Identifier used by WRS (2004) for one hundred ponds sampled within Oil Sands Region during September 2000.

(j) Identifier used by WRS (2004) for a survey of 34 lakes conducted by Alberta-Pacific Forest Industries in 1999.

– = No data.

Notes:

Critical loads and acid input rates used for the assessment are underlined in the table header.

Acid deposition rates above the critical load adjusted for organic acids are shaded.

Table 16 Predicted pH of Snowmelt for the 416 Lake Catchments Included in the Assessment

Lake Identifier(a)	Lake Name/Original Identifier	Distance [km](b)	Direction(b)	Gross Catchment Area [km^2]	Net Annual Inflow [m^3/s]	Gross Potential Acid Inputs [keq/ha/yr]				Snowmelt pH				Change in pH		
						Background	EAC	Project Case	PDC	Background	EAC	Project Case	PDC	EAC (Relative to Background)	Project Case (Relative to EAC)	PDC (Relative to EAC)
618	Unnamed WB 9-04(c)	2	W	2.1	0.004	0.07	0.17	0.19	0.21	3.7	3.2	3.2	3.2	0.42	0.05	0.09
617	Unnamed WB 7-04(c)	3	WNW	2.2	0.005	0.07	0.16	0.18	0.20	3.7	3.3	3.2	3.2	0.40	0.05	0.09
616	Unnamed WB 8-04(c)	3	W	2.4	0.005	0.07	0.16	0.18	0.19	3.7	3.3	3.2	3.2	0.39	0.04	0.09
620	Unnamed WB 11-04(c)	4	E	8.7	0.018	0.07	0.19	0.23	0.24	3.7	3.2	3.1	3.1	0.47	0.07	0.09
609	Unnamed WB 2-07(c)	5	NE	1.8	0.004	0.07	0.18	0.20	0.22	3.7	3.2	3.2	3.1	0.43	0.05	0.09
614	Unnamed WB 15-04(c)	5	WSW	0.7	0.001	0.07	0.15	0.17	0.19	3.7	3.3	3.3	3.2	0.37	0.03	0.08
231	95(d), Unnamed WB 6-04(c)	7	N	16.1	0.059	0.07	0.15	0.17	0.19	3.9	3.5	3.5	3.4	0.37	0.05	0.10
615	Unnamed WB 5-04(c)	8	NNW	5.6	0.012	0.07	0.15	0.17	0.19	3.7	3.3	3.3	3.2	0.35	0.06	0.12
610	Unnamed WB 3-07(c)	8	W	15.7	0.033	0.07	0.15	0.16	0.18	3.7	3.3	3.3	3.2	0.35	0.04	0.10
621	Unnamed WB 13-04(c)	9	SE	12.3	0.026	0.07	0.17	0.19	0.20	3.7	3.2	3.2	3.2	0.41	0.07	0.09
2	Christina	9	SW	1,233.5	2.809	0.07	0.16	0.17	0.19	3.7	3.3	3.3	3.2	0.39	0.02	0.08
612	Unnamed WB 2-04(c)	9	W	2.1	0.004	0.07	0.14	0.16	0.18	3.7	3.3	3.3	3.2	0.35	0.05	0.10
613	Unnamed WB 16-04(c)	10	WNW	6.6	0.014	0.07	0.15	0.19	0.22	3.7	3.3	3.2	3.1	0.36	0.11	0.16
611	Unnamed WB 4-07(c)	10	ENE	6.0	0.013	0.07	0.16	0.18	0.20	3.7	3.3	3.2	3.2	0.39	0.05	0.09
147	94(d), 94(354)(e),Unnamed WB 1-07(c)	10	NNW	8.5	0.016	0.07	0.15	0.16	0.18	3.6	3.3	3.2	3.2	0.35	0.04	0.10
232	97(d), Unnamed WB 12-04(c)	11	E	51.5	0.201	0.07	0.16	0.18	0.20	3.9	3.5	3.5	3.4	0.38	0.06	0.10
233	98(d)	16	WSW	25.8	0.092	0.07	0.14	0.14	0.16	3.9	3.6	3.5	3.5	0.33	0.02	0.07
241	108(d)	21	SSW	51.1	0.171	0.10	0.18	0.18	0.21	3.7	3.4	3.4	3.3	0.25	0.01	0.08
240	Kirby	22	S	22.4	0.061	0.10	0.18	0.19	0.21	3.6	3.3	3.3	3.3	0.26	0.01	0.06
237	Winefred, WB-WL(c)	23	SE	1,185.9	4.087	0.09	0.14	0.15	0.16	3.7	3.5	3.5	3.5	0.19	0.02	0.04
230	93(d)	24	NE	11.3	0.039	0.06	0.14	0.15	0.17	3.9	3.5	3.5	3.5	0.36	0.02	0.08
227	Bohn	28	N	200.8	0.565	0.07	0.15	0.15	0.18	3.8	3.4	3.4	3.3	0.36	0.01	0.08
235	101(d)	31	E	6.5	0.021	0.06	0.13	0.14	0.16	3.9	3.5	3.5	3.5	0.33	0.03	0.08
234	100(d)	31	ENE	49.6	0.205	0.06	0.14	0.14	0.16	4.0	3.6	3.6	3.6	0.34	0.02	0.07
229	Cowper	31	NNE	280.5	0.912	0.06	0.14	0.15	0.17	3.9	3.5	3.5	3.4	0.36	0.01	0.08
228	90(d)	31	NNE	19.9	0.062	0.07	0.15	0.16	0.18	3.8	3.5	3.4	3.4	0.37	0.01	0.08
238	104(d)	34	SE	8.7	0.029	0.09	0.15	0.16	0.17	3.7	3.5	3.5	3.4	0.22	0.01	0.05
132	Grist	35	SSE	118.2	0.433	0.09	0.15	0.16	0.17	3.8	3.5	3.5	3.5	0.22	<0.01	0.04
239	106(d)	36	SSE	3.5	0.006	0.10	0.16	0.17	0.18	3.4	3.1	3.1	3.1	0.22	<0.01	0.04
139	91(d), 7(f)	39	NNE	315.9	1.009	0.06	0.15	0.15	0.17	3.9	3.5	3.5	3.4	0.37	0.01	0.08
186	40(d)	40	N	27.8	0.095	0.07	0.16	0.16	0.19	3.9	3.5	3.5	3.4	0.38	<0.01	0.08
244	113(d)	40	SW	35.1	0.148	0.10	0.15	0.16	0.17	3.8	3.6	3.6	3.5	0.19	<0.01	0.05
46	UNL4(g)	40	SSW	0.9	0.002	0.10	0.16	0.16	0.22	3.4	3.2	3.2	3.0	0.20	<0.01	0.14
44	UNL1(g)	41	SW	72.0	0.254	0.10	0.15	0.16	0.17	3.7	3.5	3.5	3.5	0.19	<0.01	0.05
236	102(d)	41	E	16.1	0.061	0.06	0.12	0.13	0.14	3.9	3.6	3.6	3.6	0.30	0.02	0.07
45	UNL3(g)	42	SSW	3.7	0.014	0.10	0.16	0.16	0.21	3.7	3.5	3.5	3.4	0.20	<0.01	0.12
50	UNL13(g)	42	SW	2.0	0.008	0.10	0.15	0.15	0.17	3.7	3.5	3.5	3.5	0.18	<0.01	0.05
49	UNL12(g)	42	SW	1.8	0.007	0.10	0.15	0.16	0.17	3.7	3.5	3.5	3.5	0.19	<0.01	0.06
48	UNL7(g)	44	SW	1.5	0.005	0.10	0.15	0.15	0.17	3.6	3.5	3.4	3.4	0.19	<0.01	0.05
47	UNL5(g)	44	SSW	5.1	0.017	0.10	0.15	0.16	0.18	3.7	3.5	3.5	3.4	0.19	<0.01	0.06
43	Ipiatik	46	SSW	56.0	0.182	0.10	0.15	0.16	0.18	3.7	3.5	3.5	3.4	0.19	<0.01	0.06
42	Wiau	47	SW	339.0	1.117	0.10	0.14	0.14	0.16	3.7	3.5	3.5	3.5	0.16	<0.01	0.04
243	111(d)	49	WSW	24.6	0.091	0.10	0.14	0.14	0.16	3.7	3.6	3.6	3.5	0.16	<0.01	0.04
222	81(d)	55	NW	40.0	0.187	0.07	0.12	0.12	0.14	4.0	3.8	3.7	3.7	0.26	<0.01	0.08
167	Wappau	57	WSW	75.9	0.190	0.06	0.10	0.10	0.11	3.8	3.5	3.5	3.5	0.23	<0.01	0.05
242	110(d)	58	WSW	11.7	0.040	0.10	0.14	0.14	0.15	3.7	3.6	3.5	3.5	0.13	<0.01	0.04
245	114(d)	59	WSW	7.2	0.024	0.10	0.14	0.14	0.15	3.7	3.5	3.5	3.5	0.14	<0.01	0.04
180	33(d)	60	NNW	14.2	0.067	0.07	0.18	0.18	0.22	4.0	3.6	3.6	3.5	0.44	<0.01	0.09
184	Watchusk	61	NNE	301.8	0.883	0.06	0.14	0.15	0.17	3.8	3.5	3.5	3.4	0.36	<0.01	0.08
130	32(d), 2(f)	62	NNW	30.4	0.128	0.07	0.18	0.18	0.22	4.0	3.5	3.5	3.4	0.43	<0.01	0.09
136	34(d), 1(f)	63	NW	73.8	0.301	0.07	0.13	0.13	0.16	3.9	3.7	3.7	3.6	0.30	<0.01	0.09
248	Clyde	63	SW	470.3	0.488	0.10	0.14	0.14	0.15	3.2	3.0	3.0	3.0	0.14	<0.01	0.03
247	117(d)	63	SW	9.3	0.036	0.10	0.14	0.14	0.15	3.7	3.6	3.6	3.6	0.13	<0.01	0.03
221	80(d)	64	WNW	2.7	0.006	0.06	0.11	0.11	0.14	3.7	3.4	3.4	3.3	0.25	<0.01	0.13
145	28(d), 28(290)(e)	64	NNW	3.2	0.012	0.07	0.17	0.17	0.21	3.9	3.5	3.5	3.4	0.41	<0.01	0.09
178	30(d)	65	NNW	21.5	0.102	0.07	0.17	0.17	0.21	4.0	3.6	3.6	3.5	0.41	<0.01	0.09
181	35(d)	65	NNE	201.5	0.593	0.06	0.15	0.15	0.18	3.8	3.4	3.4	3.4	0.38	<0.01	0.08
250	120(d)	65	SW	15.8	0.056	0.10	0.14	0.14	0.15	3.7	3.6	3.5	3.5	0.15	<0.01	0.03

Table 16 Predicted pH of Snowmelt for the 416 Lake Catchments Included in the Assessment (continued)

Lake Identifier(a)	Lake Name/Original Identifier	Distance [km](b)	Direction(b)	Gross Catchment Area [km^2]	Net Annual Inflow [m^3/s]	Gross Potential Acid Inputs [keq/ha/yr]				Snowmelt pH				Change in pH		
						Background	EAC	Project Case	PDC	Background	EAC	Project Case	PDC	EAC (Relative to Background)	Project Case (Relative to EAC)	PDC (Relative to EAC)
185	39(d)	66	NE	27.4	0.078	0.06	0.14	0.14	0.16	3.8	3.5	3.5	3.4	0.34	<0.01	0.07
138	Goodwin	66	WSW	34.6	0.100	0.10	0.14	0.14	0.15	3.6	3.5	3.5	3.4	0.14	<0.01	0.03
249	Behan	67	SW	65.5	0.080	0.10	0.14	0.14	0.15	3.2	3.1	3.1	3.1	0.13	<0.01	0.03
176	20(d)	67	N	54.0	0.184	0.07	0.18	0.18	0.22	3.9	3.4	3.4	3.3	0.44	<0.01	0.09
143	25(d), 25(287)(e)	67	NNW	7.8	0.022	0.07	0.17	0.17	0.21	3.8	3.4	3.4	3.3	0.42	<0.01	0.09
175	Georges	68	N	155.8	0.543	0.07	0.20	0.20	0.26	3.9	3.4	3.4	3.3	0.49	<0.01	0.12
117	26(d), A26(e)	68	NNW	11.7	0.037	0.07	0.18	0.18	0.22	3.8	3.4	3.4	3.3	0.43	<0.01	0.10
122	86(d), A86(e)	70	W	4.8	0.012	0.06	0.10	0.10	0.12	3.8	3.5	3.5	3.5	0.23	<0.01	0.06
183	37(d)	70	NNE	37.0	0.068	0.06	0.14	0.14	0.16	3.6	3.3	3.3	3.2	0.34	<0.01	0.07
177	22(d)	70	NNW	18.8	0.067	0.07	0.18	0.18	0.22	3.9	3.5	3.5	3.4	0.44	<0.01	0.10
179	31(d)	70	NNW	6.4	0.025	0.07	0.16	0.16	0.20	3.9	3.6	3.5	3.5	0.39	<0.01	0.10
116	24(d), A24(e)	70	NNW	8.8	0.034	0.07	0.17	0.17	0.21	3.9	3.5	3.5	3.4	0.41	<0.01	0.10
218	77(d)	71	WNW	147.3	0.709	0.06	0.11	0.11	0.13	4.1	3.8	3.8	3.7	0.24	<0.01	0.09
146	82(d), 82(342)(e)	71	WNW	6.1	0.014	0.06	0.10	0.11	0.12	3.7	3.5	3.5	3.4	0.24	<0.01	0.07
131	Base	71	W	64.1	0.328	0.06	0.10	0.10	0.12	4.1	3.9	3.8	3.8	0.23	<0.01	0.06
225	85(d)	71	W	6.4	0.021	0.06	0.10	0.10	0.12	3.9	3.6	3.6	3.6	0.23	<0.01	0.06
144	27(d), 27(289)(e)	72	NW	7.1	0.022	0.07	0.15	0.15	0.20	3.8	3.5	3.4	3.3	0.37	<0.01	0.10
220	79(d)	72	WNW	15.6	0.060	0.06	0.11	0.11	0.13	4.0	3.7	3.7	3.6	0.24	<0.01	0.08
246	116(d)	73	WSW	11.2	0.037	0.10	0.14	0.14	0.15	3.7	3.5	3.5	3.5	0.14	<0.01	0.03
38	L8(g)	74	NNW	0.8	0.003	0.07	0.19	0.20	0.25	3.9	3.4	3.4	3.3	0.48	<0.01	0.10
115	21(d), A21(e)	74	NNW	14.7	0.087	0.07	0.18	0.18	0.22	4.1	3.7	3.7	3.6	0.44	<0.01	0.10
224	84(d)	75	W	9.3	0.029	0.06	0.10	0.10	0.12	3.9	3.6	3.6	3.6	0.23	<0.01	0.06
251	Big Chief	76	SW	13.0	0.038	0.10	0.14	0.14	0.15	3.6	3.5	3.5	3.5	0.13	<0.01	0.03
36	UNL3(g)	76	N	1.6	0.003	0.07	0.26	0.26	0.32	3.7	3.1	3.1	3.0	0.60	<0.01	0.09
174	17(d)	76	NNW	40.7	0.188	0.07	0.20	0.20	0.25	4.0	3.5	3.5	3.4	0.48	<0.01	0.10
118	29(d), A29(e)	76	NW	5.2	0.017	0.06	0.13	0.13	0.16	3.9	3.6	3.6	3.5	0.33	<0.01	0.10
37	Surmont	77	NNW	82.4	0.313	0.07	0.20	0.20	0.25	3.9	3.4	3.4	3.3	0.49	<0.01	0.10
259	Logan	77	SSW	244.6	0.931	0.10	0.14	0.14	0.15	3.7	3.6	3.6	3.6	0.14	<0.01	0.03
219	78(d)	78	WNW	23.3	0.102	0.06	0.10	0.11	0.12	4.0	3.8	3.8	3.7	0.24	<0.01	0.07
182	Formby	78	NNE	51.1	0.132	0.06	0.13	0.13	0.15	3.8	3.4	3.4	3.4	0.32	<0.01	0.07
258	128(d)	79	SW	12.0	0.041	0.10	0.14	0.14	0.14	3.7	3.6	3.6	3.5	0.14	<0.01	0.03
27	Pushup	81	N	0.9	0.002	0.07	0.30	0.30	0.35	3.6	3.0	3.0	2.9	0.67	<0.01	0.06
223	83(d)	81	WNW	38.1	0.166	0.06	0.10	0.10	0.12	4.0	3.8	3.8	3.7	0.23	<0.01	0.06
110	Birch (d)	82	NNE	73.7	0.126	0.06	0.16	0.16	0.19	3.6	3.2	3.2	3.1	0.40	<0.01	0.08
34	UNL1(g)	82	N	2.3	0.007	0.07	0.30	0.30	0.35	3.8	3.1	3.1	3.1	0.67	<0.01	0.06
1	Birch (h)	83	N	3.7	0.011	0.07	0.32	0.32	0.37	3.8	3.1	3.1	3.1	0.70	<0.01	0.06
39	L10(g)	83	NNW	1.9	0.004	0.07	0.21	0.21	0.26	3.7	3.2	3.2	3.0	0.50	<0.01	0.10
31	Rat	83	N	20.6	0.062	0.07	0.32	0.32	0.37	3.8	3.1	3.1	3.1	0.69	<0.01	0.06
40	L11(g)	84	NNW	0.5	0.002	0.07	0.21	0.21	0.26	3.9	3.4	3.4	3.3	0.51	<0.01	0.10
26	Long (d)	84	N	4.5	0.012	0.07	0.29	0.29	0.34	3.8	3.1	3.1	3.1	0.65	<0.01	0.06
28	Sucker	84	N	5.1	0.013	0.07	0.29	0.29	0.33	3.7	3.1	3.1	3.0	0.65	<0.01	0.06
30	Poison	85	N	0.9	0.001	0.07	0.30	0.30	0.34	3.6	2.9	2.9	2.8	0.66	<0.01	0.06
204	63(d)	85	WNW	40.1	0.165	0.06	0.10	0.11	0.12	4.0	3.7	3.7	3.7	0.24	<0.01	0.07
41	Maqua	86	NNW	6.1	0.022	0.07	0.21	0.21	0.27	3.9	3.4	3.4	3.3	0.50	<0.01	0.11
257	Heart	86	SW	495.1	1.760	0.10	0.13	0.13	0.14	3.7	3.6	3.6	3.6	0.12	<0.01	0.02
29	Frog	86	N	8.3	0.025	0.07	0.27	0.27	0.31	3.8	3.2	3.2	3.1	0.62	<0.01	0.06
173	Garson	87	NNE	340.0	0.791	0.06	0.13	0.13	0.15	3.7	3.4	3.4	3.3	0.32	<0.01	0.06
226	88(d)	87	WNW	8.1	0.026	0.06	0.10	0.10	0.12	3.9	3.7	3.7	3.6	0.23	<0.01	0.06
202	Mariana	88	WNW	2.4	0.008	0.06	0.10	0.10	0.12	3.9	3.6	3.6	3.6	0.23	<0.01	0.06
171	Gipsy	88	NNE	94.8	0.063	0.06	0.14	0.15	0.17	3.2	2.8	2.8	2.7	0.37	<0.01	0.07
35	PF12(i), UNL2(g)	88	NNW	3.3	0.009	0.07	0.23	0.23	0.27	3.8	3.2	3.2	3.2	0.55	<0.01	0.07
207	66(d)	89	W	14.6	0.057	0.06	0.10	0.10	0.11	4.0	3.8	3.8	3.7	0.21	<0.01	0.05
33	Kiskatinaw	89	NNW	30.1	0.090	0.07	0.22	0.22	0.26	3.8	3.3	3.3	3.2	0.54	<0.01	0.07
68	LK8(g)	90	SSE	3.2	0.006	0.09	0.20	0.21	0.21	3.5	3.1	3.1	3.1	0.34	<0.01	0.02
515	Unnamed 5(g)	90	S	5.8	0.008	0.10	0.23	0.23	0.24	3.3	2.9	2.9	2.9	0.37	<0.01	0.02
598	UN-5(g)	90	S	247.6	0.701	0.10	0.23	0.23	0.24	3.6	3.2	3.2	3.2	0.37	<0.01	0.02
256	Piche	90	SW	555.1	1.981	0.10	0.14	0.14	0.14	3.7	3.6	3.6	3.6	0.12	<0.01	0.02
25	Canoe	90	NNW	6.1	0.012	0.07	0.22	0.22	0.26	3.6	3.1	3.1	3.0	0.52	<0.01	0.07

Table 16 Predicted pH of Snowmelt for the 416 Lake Catchments Included in the Assessment (continued)

Lake Identifier(a)	Lake Name/Original Identifier	Distance [km](b)	Direction(b)	Gross Catchment Area [km^2]	Net Annual Inflow [m^3/s]	Gross Potential Acid Inputs [keq/ha/yr]				Snowmelt pH				Change in pH		
						Background	EAC	Project Case	PDC	Background	EAC	Project Case	PDC	EAC (Relative to Background)	Project Case (Relative to EAC)	PDC (Relative to EAC)
203	62(d)	90	WNW	7.1	0.029	0.06	0.11	0.11	0.12	4.0	3.7	3.7	3.7	0.25	<0.01	0.06
597	UN-2(g)	91	S	237.2	0.672	0.10	0.21	0.21	0.21	3.6	3.3	3.3	3.3	0.32	<0.01	0.02
253	123(d)	91	SW	7.9	0.027	0.10	0.13	0.13	0.14	3.7	3.6	3.6	3.5	0.12	<0.01	0.02
170	Nora	91	N	4.9	0.009	0.07	0.16	0.16	0.19	3.6	3.2	3.2	3.1	0.39	<0.01	0.08
205	Crow	92	W	66.4	0.286	0.06	0.10	0.10	0.11	4.0	3.8	3.8	3.7	0.21	<0.01	0.06
463	PF9(i)	93	NNW	1.3	0.004	0.07	0.19	0.19	0.23	3.8	3.4	3.4	3.3	0.47	<0.01	0.08
206	65(d)	93	W	111.4	0.475	0.06	0.10	0.10	0.11	4.0	3.8	3.8	3.7	0.20	<0.01	0.05
254	124(d)	93	SW	125.0	0.313	0.10	0.13	0.13	0.14	3.5	3.4	3.4	3.4	0.11	<0.01	0.02
67	LK7(g)	93	SSE	8.1	0.017	0.09	0.21	0.21	0.22	3.5	3.1	3.1	3.1	0.36	<0.01	0.02
172	Baker	93	NNE	16.5	0.035	0.06	0.14	0.14	0.16	3.7	3.3	3.3	3.3	0.35	<0.01	0.07
453	PF11(i)	93	NNW	1.3	0.005	0.07	0.20	0.20	0.23	3.9	3.4	3.4	3.3	0.48	<0.01	0.08
3	Gregoire	93	NNW	231.3	0.666	0.07	0.19	0.19	0.23	3.8	3.3	3.3	3.3	0.47	<0.01	0.08
252	122(d)	93	SW	18.8	0.049	0.10	0.13	0.13	0.14	3.6	3.4	3.4	3.4	0.12	<0.01	0.02
109	Gordon	94	N	535.3	0.650	0.04	0.14	0.14	0.17	3.6	3.1	3.1	3.0	0.52	<0.01	0.08
452	PF10(i)	94	NNW	1.1	0.004	0.07	0.19	0.19	0.23	3.9	3.4	3.4	3.3	0.47	<0.01	0.08
599	UN-6(g)	95	S	247.8	0.701	0.10	0.23	0.24	0.24	3.6	3.2	3.2	3.2	0.37	<0.01	0.01
66	LK6(g)	96	SSE	3.8	0.008	0.09	0.21	0.21	0.22	3.5	3.1	3.1	3.1	0.36	<0.01	0.02
461	PF7(i)	96	NNW	1.6	0.006	0.07	0.19	0.20	0.24	3.9	3.4	3.4	3.3	0.48	<0.01	0.08
169	Shortt	96	NNE	169.0	0.294	0.06	0.13	0.13	0.15	3.6	3.3	3.3	3.2	0.33	<0.01	0.07
65	LK5(g)	97	SSE	17.9	0.036	0.09	0.22	0.22	0.23	3.5	3.1	3.1	3.1	0.38	<0.01	0.02
32	Caribou Horn	97	N	8.5	0.024	0.04	0.17	0.17	0.20	4.0	3.4	3.4	3.3	0.60	<0.01	0.08
64	LK4(g)	98	SSE	6.6	0.012	0.09	0.22	0.23	0.23	3.5	3.1	3.1	3.1	0.39	<0.01	0.02
60	Burnt	98	S	141.4	0.264	0.09	0.22	0.22	0.23	3.5	3.1	3.1	3.1	0.38	<0.01	0.02
255	125(d)	98	SW	22.0	0.083	0.10	0.13	0.13	0.14	3.7	3.6	3.6	3.6	0.11	<0.01	0.02
63	LK3(g)	99	SSE	2.0	0.004	0.09	0.23	0.23	0.24	3.5	3.1	3.1	3.1	0.39	<0.01	0.01
455	PF13(i)	99	N	1.6	0.005	0.04	0.17	0.17	0.21	4.0	3.4	3.4	3.3	0.60	<0.01	0.08
62	LK2(g)	100	SSE	0.8	0.001	0.09	0.23	0.23	0.24	3.4	3.0	3.0	3.0	0.40	<0.01	0.01
198	56(d)	101	WNW	20.6	0.081	0.06	0.11	0.11	0.12	4.0	3.7	3.7	3.7	0.25	<0.01	0.06
61	LK1(g)	102	SSE	12.1	0.024	0.09	0.24	0.24	0.25	3.5	3.1	3.1	3.1	0.42	<0.01	0.01
536	Touchwood	103	SSW	137.3	0.213	0.10	0.13	0.13	0.14	3.3	3.2	3.2	3.2	0.13	<0.01	0.02
208	67(d)	104	W	34.6	0.155	0.06	0.09	0.09	0.10	4.0	3.8	3.8	3.8	0.18	<0.01	0.05
168	8(d)	105	NNE	22.0	0.073	0.04	0.12	0.12	0.14	4.0	3.6	3.6	3.5	0.43	<0.01	0.08
516	Sinclair (d)	105	S	56.9	0.094	0.10	0.19	0.19	0.20	3.4	3.1	3.1	3.1	0.28	<0.01	0.01
199	57(d)	107	WNW	18.1	0.060	0.06	0.10	0.10	0.12	3.9	3.7	3.7	3.6	0.23	<0.01	0.05
69	May	108	SSE	189.0	0.300	0.09	0.22	0.22	0.22	3.4	3.0	3.0	3.0	0.37	<0.01	0.01
201	60(d)	108	WNW	53.9	0.222	0.06	0.10	0.10	0.11	4.0	3.8	3.8	3.7	0.21	<0.01	0.05
538	Wolf	109	S	754.7	1.663	0.10	0.15	0.15	0.16	3.5	3.3	3.3	3.3	0.18	<0.01	0.02
462	PF8(i)	110	NNW	1.6	0.005	0.04	0.19	0.19	0.22	4.0	3.4	3.3	3.3	0.64	<0.01	0.08
517	Bourque	110	S	100.0	0.149	0.10	0.21	0.21	0.21	3.3	3.0	3.0	3.0	0.32	<0.01	0.01
142	6(d), 6(271)(e)	113	NNE	22.0	0.049	0.04	0.13	0.13	0.15	3.9	3.4	3.4	3.3	0.47	<0.01	0.08
209	Agnes (d)	114	W	43.9	0.175	0.08	0.10	0.10	0.11	3.9	3.8	3.8	3.7	0.10	<0.01	0.05
196	54(d)	117	NW	5.2	0.016	0.06	0.12	0.12	0.14	3.9	3.6	3.6	3.5	0.30	<0.01	0.06
530	La Loche	117	NE	1,410.4	1.791	0.06	0.11	0.11	0.12	3.5	3.2	3.2	3.2	0.24	<0.01	0.05
518	Marguerite	117	S	39.3	0.010	0.10	0.16	0.17	0.17	2.5	2.3	2.3	2.3	0.22	<0.01	0.01
519	Marie	118	SSE	478.0	0.665	0.09	0.20	0.20	0.21	3.3	3.0	3.0	3.0	0.34	<0.01	0.01
459	PF5(i)	120	NNW	0.5	0.001	0.05	0.17	0.17	0.20	3.9	3.3	3.3	3.3	0.56	<0.01	0.08
520	Leming	120	S	44.0	0.059	0.09	0.25	0.25	0.25	3.3	2.9	2.9	2.9	0.43	<0.01	0.01
460	PF6(i)	120	NW	0.7	0.002	0.05	0.17	0.17	0.20	4.0	3.4	3.4	3.4	0.55	<0.01	0.08
195	53(d)	121	NW	17.3	0.062	0.06	0.12	0.12	0.14	3.9	3.6	3.6	3.6	0.31	<0.01	0.06
540	Pinehurst	122	SSW	186.0	0.278	0.10	0.13	0.13	0.13	3.3	3.2	3.2	3.2	0.10	<0.01	0.01
194	Algar	122	NW	63.2	0.177	0.06	0.12	0.12	0.14	3.8	3.5	3.5	3.5	0.30	<0.01	0.06
537	La Biche	123	SW	4,279.2	11.154	0.10	0.12	0.12	0.13	3.6	3.5	3.5	3.5	0.08	<0.01	0.02
141	4(d), 4(270)(e)	123	N	18.1	0.041	0.04	0.18	0.18	0.21	3.9	3.3	3.3	3.2	0.62	<0.01	0.07
197	55(d)	124	WNW	18.2	0.061	0.06	0.11	0.11	0.13	3.9	3.6	3.6	3.6	0.27	<0.01	0.06
600	Dolly	125	SSE	244.3	0.691	0.09	0.19	0.19	0.19	3.6	3.3	3.3	3.3	0.31	<0.01	0.01
521	Tucker	126	S	277.0	0.461	0.10	0.17	0.17	0.17	3.4	3.1	3.1	3.1	0.23	<0.01	0.01
533	McLean	128	NE	235.4	0.327	0.06	0.10	0.10	0.11	3.5	3.3	3.3	3.2	0.20	<0.01	0.05
522	Ethel	128	S	594.0	0.647	0.09	0.20	0.20	0.20	3.2	2.9	2.9	2.9	0.33	<0.01	0.01

Table 16 Predicted pH of Snowmelt for the 416 Lake Catchments Included in the Assessment (continued)

Lake Identifier(a)	Lake Name/Original Identifier	Distance [km](b)	Direction(b)	Gross Catchment Area [km^2]	Net Annual Inflow [m^3/s]	Gross Potential Acid Inputs [keq/ha/yr]				Snowmelt pH				Change in pH		
						Background	EAC	Project Case	PDC	Background	EAC	Project Case	PDC	EAC (Relative to Background)	Project Case (Relative to EAC)	PDC (Relative to EAC)
523	Hilda	129	S	79.8	0.051	0.09	0.17	0.17	0.18	3.0	2.7	2.7	2.7	0.27	<0.01	0.01
450	P99(i)	130	NNW	0.5	0.002	0.05	0.21	0.21	0.25	4.0	3.3	3.3	3.2	0.64	<0.01	0.08
546	Cold	131	SSE	6,513.0	18.180	0.09	0.17	0.17	0.17	3.6	3.4	3.4	3.4	0.26	<0.01	0.01
451	PF1(i)	131	NNW	0.6	0.002	0.05	0.18	0.18	0.21	4.0	3.4	3.4	3.3	0.58	<0.01	0.07
456	PF2(i)	131	NNW	0.7	0.002	0.05	0.20	0.20	0.23	4.0	3.4	3.4	3.3	0.62	<0.01	0.08
457	PF3(i)	131	NW	0.7	0.002	0.05	0.17	0.17	0.20	3.9	3.3	3.3	3.3	0.55	<0.01	0.07
211	70(d)	131	W	11.5	0.038	0.08	0.11	0.11	0.12	3.8	3.6	3.6	3.6	0.15	<0.01	0.04
458	PF4(i)	131	NNW	0.3	0.001	0.05	0.18	0.18	0.22	4.0	3.4	3.4	3.3	0.59	<0.01	0.07
539	Field	132	SW	12.7	0.033	0.10	0.12	0.13	0.13	3.6	3.5	3.5	3.5	0.09	<0.01	0.01
596	Manatokan	135	S	409.3	1.152	0.08	0.11	0.11	0.11	3.7	3.6	3.6	3.5	0.14	<0.01	0.02
210	69(d)	135	W	12.6	0.041	0.08	0.10	0.10	0.11	3.8	3.7	3.6	3.6	0.14	<0.01	0.04
129	2(d), 15(f), E15(L15b)(e)	137	N	25.0	0.081	0.04	0.20	0.20	0.23	4.0	3.4	3.4	3.3	0.66	<0.01	0.07
135	3(d), 16(f)	137	NNE	10.9	0.037	0.04	0.12	0.12	0.14	4.0	3.6	3.6	3.5	0.43	<0.01	0.07
121	59(d), A59(e)	137	WNW	44.8	0.174	0.08	0.11	0.11	0.12	3.9	3.7	3.7	3.7	0.15	<0.01	0.04
405	P101(i)	138	NNW	1.1	0.004	0.05	0.22	0.22	0.26	4.0	3.3	3.3	3.3	0.67	<0.01	0.08
212	71(d)	138	W	21.9	0.084	0.08	0.10	0.10	0.11	3.9	3.7	3.7	3.7	0.14	<0.01	0.04
479	PTH12(i)	140	N	1.2	0.004	0.04	0.26	0.26	0.32	4.1	3.3	3.3	3.2	0.77	<0.01	0.10
156	P98(i), P98(e)	141	NNW	1.9	0.007	0.05	0.27	0.27	0.32	4.0	3.3	3.3	3.2	0.76	<0.01	0.08
214	73(d)	142	W	24.9	0.092	0.08	0.10	0.10	0.11	3.8	3.7	3.7	3.7	0.13	<0.01	0.03
155	P97(i), P97(e)	142	NNW	1.8	0.006	0.05	0.31	0.31	0.37	4.0	3.2	3.2	3.1	0.82	<0.01	0.08
213	72(d)	142	W	7.7	0.025	0.08	0.10	0.10	0.11	3.8	3.7	3.7	3.6	0.13	<0.01	0.03
134	1(d), 25(f), 1(267)(e)	144	NNW	34.5	0.118	0.05	0.19	0.19	0.23	4.0	3.4	3.4	3.3	0.61	<0.01	0.08
200	58(d)	145	WNW	21.6	0.078	0.08	0.10	0.11	0.11	3.8	3.7	3.7	3.7	0.15	<0.01	0.04
154	P96(i), P96(e)	147	NNW	1.3	0.003	0.05	0.21	0.21	0.25	3.9	3.3	3.3	3.2	0.65	<0.01	0.08
416	P30(i)	147	N	1.8	0.006	0.04	0.26	0.26	0.30	4.0	3.2	3.2	3.2	0.79	<0.01	0.06
478	PTH11(i)	147	N	2.7	0.010	0.04	0.29	0.29	0.34	4.1	3.2	3.2	3.2	0.83	<0.01	0.07
608	Suncor_VS_UW1	149	NNW	5.8	0.017	0.04	0.48	0.48	0.54	4.0	2.9	2.9	2.9	1.05	<0.01	0.05
467	PM4(i)	149	N	17.4	0.066	0.04	0.26	0.26	0.30	4.1	3.3	3.3	3.2	0.79	<0.01	0.06
215	Long (h)	149	W	31.1	0.111	0.08	0.10	0.10	0.11	3.8	3.7	3.7	3.7	0.12	<0.01	0.03
425	P47(i)	150	N	16.7	0.063	0.04	0.27	0.27	0.31	4.1	3.3	3.3	3.2	0.79	<0.01	0.06
58	Shipyard	151	NNW	42.9	0.130	0.04	0.86	0.86	0.85	4.0	2.7	2.7	2.7	1.30	<0.01	0.00
449	P95(i)	152	NNW	1.6	0.006	0.05	0.21	0.21	0.25	4.0	3.4	3.4	3.3	0.65	<0.01	0.08
424	P46(i)	152	N	1.4	0.005	0.04	0.28	0.28	0.32	4.1	3.2	3.2	3.2	0.81	<0.01	0.06
140	L5(j), P28(i)	154	N	11.8	0.048	0.04	0.26	0.26	0.30	4.1	3.3	3.3	3.3	0.78	<0.01	0.06
84	L8(j), L8(e)	154	N	10.6	0.045	0.04	0.20	0.20	0.23	4.1	3.5	3.5	3.4	0.67	<0.01	0.07
216	75(d)	156	W	4.1	0.007	0.08	0.10	0.10	0.11	3.5	3.4	3.4	3.3	0.12	<0.01	0.03
319	L6(j)	157	N	32.4	0.137	0.04	0.25	0.25	0.29	4.1	3.4	3.4	3.3	0.77	<0.01	0.06
83	L7(j), L7(e)	159	N	21.5	0.101	0.04	0.24	0.24	0.28	4.2	3.4	3.4	3.4	0.75	<0.01	0.06
217	Pelican	160	W	283.2	0.962	0.08	0.10	0.10	0.11	3.8	3.7	3.7	3.7	0.12	<0.01	0.03
190	46(d)	161	WNW	33.7	0.131	0.08	0.11	0.11	0.12	3.9	3.7	3.7	3.7	0.17	<0.01	0.04
161	49(d), A300(e)	164	WNW	25.0	0.026	0.08	0.11	0.11	0.12	3.3	3.1	3.1	3.1	0.16	<0.01	0.04
191	48(d)	164	WNW	3.3	0.008	0.08	0.11	0.11	0.12	3.7	3.5	3.5	3.5	0.17	<0.01	0.04
329	Mildred	164	NNW	9.1	0.015	0.05	0.78	0.78	0.87	3.7	2.5	2.5	2.4	1.22	<0.01	0.05
422	P44(i)	164	N	2.3	0.009	0.04	0.19	0.19	0.23	4.1	3.5	3.5	3.4	0.65	<0.01	0.07
120	47(d), A47(e)	165	WNW	8.6	0.034	0.08	0.11	0.11	0.12	3.9	3.7	3.7	3.7	0.17	<0.01	0.04
150	P27(i), P27(e)	165	N	4.0	0.017	0.04	0.27	0.27	0.31	4.1	3.4	3.4	3.3	0.80	<0.01	0.06
82	170(d), 14(f), L4(j), A170(L4)(e)	165	N	18.2	0.083	0.04	0.27	0.27	0.31	4.2	3.4	3.4	3.3	0.79	<0.01	0.06
423	P45(i)	166	N	1.3	0.004	0.04	0.17	0.17	0.20	4.0	3.4	3.4	3.3	0.61	<0.01	0.07
322	L15(j)	166	N	8.0	0.026	0.04	0.12	0.12	0.15	4.0	3.6	3.6	3.5	0.45	<0.01	0.08
477	PTH10(i)	166	N	8.4	0.028	0.04	0.32	0.32	0.37	4.0	3.2	3.2	3.1	0.87	<0.01	0.07
137	Wood Buffalo	167	WNW	81.4	0.332	0.08	0.11	0.11	0.12	3.9	3.7	3.7	3.7	0.18	<0.01	0.04
535	Turnor	167	NE	2,551.5	3.579	0.04	0.08	0.08	0.09	3.7	3.4	3.4	3.3	0.27	<0.01	0.05
485	PTH9(i)	167	N	2.6	0.007	0.04	0.32	0.32	0.37	4.0	3.1	3.1	3.0	0.87	<0.01	0.07
314	Sandy (d)	169	W	395.4	1.084	0.08	0.10	0.10	0.10	3.7	3.6	3.6	3.6	0.11	<0.01	0.03
193	50(d)	170	WNW	38.3	0.148	0.08	0.11	0.11	0.12	3.9	3.7	3.7	3.7	0.16	<0.01	0.04
320	L9(j)	170	N	33.4	0.135	0.04	0.16	0.16	0.21	4.1	3.5	3.5	3.4	0.57	<0.01	0.10
189	45(d)	171	WNW	119.5	0.496	0.08	0.11	0.11	0.12	3.9	3.7	3.7	3.7	0.17	<0.01	0.04
119	42(d), A42(e)	172	WNW	25.1	0.088	0.08	0.11	0.11	0.12	3.8	3.6	3.6	3.6	0.18	<0.01	0.04

Table 16 Predicted pH of Snowmelt for the 416 Lake Catchments Included in the Assessment (continued)

Lake Identifier$^{(a)}$	Lake Name/Original Identifier	Distance [km]$^{(b)}$	Direction$^{(b)}$	Gross Catchment Area [km^2]	Net Annual Inflow [m^3/s]	Gross Potential Acid Inputs [keq/ha/yr]				Snowmelt pH				Change in pH		
						Background	EAC	Project Case	PDC	Background	EAC	Project Case	PDC	EAC (Relative to Background)	Project Case (Relative to EAC)	PDC (Relative to EAC)
414	P25$^{(i)}$	172	N	8.6	0.036	0.04	0.31	0.31	0.35	4.1	3.3	3.3	3.2	0.85	<0.01	0.06
445	P9$^{(i)}$	172	N	4.9	0.020	0.04	0.20	0.20	0.24	4.1	3.4	3.4	3.4	0.67	<0.01	0.07
188	44$^{(d)}$	173	WNW	156.9	0.654	0.08	0.11	0.11	0.12	3.9	3.7	3.7	3.7	0.17	<0.01	0.04
306	Horsetail	173	WNW	124.7	0.393	0.08	0.10	0.10	0.11	3.8	3.6	3.6	3.6	0.13	<0.01	0.03
413	P24$^{(i)}$	174	N	7.6	0.032	0.04	0.33	0.33	0.38	4.1	3.3	3.3	3.2	0.88	<0.01	0.06
440	P8$^{(i)}$	174	N	2.1	0.008	0.04	0.27	0.27	0.31	4.1	3.3	3.3	3.3	0.79	<0.01	0.06
152	P7$^{(i)}$, P7$^{(e)}$	174	N	1.9	0.007	0.04	0.28	0.28	0.32	4.1	3.3	3.3	3.2	0.81	<0.01	0.06
606	P2	174	NNW	9.5	0.018	0.04	0.72	0.72	1.40	3.8	2.6	2.6	2.3	1.23	<0.01	0.29
432	P6$^{(i)}$	175	N	4.0	0.016	0.04	0.31	0.31	0.35	4.1	3.3	3.3	3.2	0.86	<0.01	0.05
316	D254$^{(h)}$	176	NW	390.6	1.484	0.05	0.10	0.10	0.11	4.0	3.8	3.8	3.7	0.25	<0.01	0.05
421	P43$^{(i)}$	177	N	3.5	0.014	0.04	0.33	0.33	0.37	4.1	3.2	3.2	3.2	0.88	<0.01	0.05
318	L3$^{(j)}$	178	N	7.2	0.030	0.04	0.34	0.34	0.39	4.1	3.2	3.2	3.2	0.90	<0.01	0.06
149	P23$^{(i)}$, P23$^{(e)}$	178	N	7.3	0.030	0.04	0.37	0.37	0.41	4.1	3.2	3.2	3.1	0.93	<0.01	0.05
466	PM3$^{(i)}$	178	N	1.0	0.004	0.04	0.35	0.35	0.40	4.1	3.2	3.2	3.2	0.91	<0.01	0.06
465	PM2$^{(i)}$	178	N	0.7	0.003	0.04	0.36	0.36	0.41	4.1	3.2	3.2	3.2	0.92	<0.01	0.06
317	L2$^{(j)}$	179	N	9.8	0.041	0.04	0.35	0.35	0.40	4.1	3.2	3.2	3.2	0.91	<0.01	0.06
56	UW6$^{(g)}$	179	NNW	9.7	0.017	0.05	0.96	0.96	1.78	3.7	2.4	2.4	2.1	1.31	<0.01	0.27
464	PM1$^{(i)}$	179	N	0.5	0.002	0.04	0.35	0.35	0.40	4.1	3.2	3.2	3.2	0.91	<0.01	0.06
55	UW5$^{(g)}$	179	NNW	12.4	0.023	0.04	0.90	0.90	1.46	3.8	2.5	2.5	2.3	1.32	<0.01	0.21
605	P1	179	NNW	18.3	0.035	0.04	0.93	0.94	1.55	3.8	2.5	2.5	2.2	1.34	<0.01	0.22
52	UW2$^{(g)}$	179	NNW	36.9	0.070	0.05	0.95	0.95	1.58	3.8	2.5	2.5	2.2	1.30	<0.01	0.22
53	UW3$^{(g)}$	179	NNW	20.6	0.039	0.04	0.94	0.94	1.55	3.8	2.5	2.5	2.2	1.34	<0.01	0.22
51	UW1$^{(g)}$	179	NNW	20.5	0.039	0.05	0.95	0.95	1.57	3.8	2.4	2.4	2.2	1.31	<0.01	0.22
607	P4	180	NNW	6.6	0.012	0.04	0.94	0.94	1.49	3.8	2.4	2.4	2.2	1.34	<0.01	0.20
54	UW4$^{(g)}$	180	NNW	12.6	0.023	0.04	0.94	0.94	1.46	3.8	2.4	2.4	2.2	1.34	<0.01	0.19
88	168$^{(d)}$, 12$^{(f)}$, L14$^{(j)}$	180	N	29.5	0.096	0.04	0.13	0.13	0.15	4.0	3.6	3.6	3.5	0.46	<0.01	0.07
81	L1$^{(j)}$, L1$^{(e)}$	181	N	4.3	0.016	0.04	0.33	0.34	0.39	4.1	3.2	3.2	3.1	0.89	<0.01	0.06
532	unnamed	181	NE	21.0	0.107	0.04	0.09	0.09	0.10	4.2	3.9	3.9	3.9	0.30	<0.01	0.05
87	167$^{(d)}$, L13$^{(j)}$	181	N	15.7	0.047	0.04	0.13	0.13	0.15	4.0	3.5	3.5	3.4	0.47	<0.01	0.06
447	P91$^{(i)}$	182	NNW	13.7	0.043	0.05	0.15	0.15	0.19	4.0	3.5	3.5	3.4	0.51	<0.01	0.08
153	P94$^{(i)}$, P94$^{(e)}$	182	NNW	0.7	0.002	0.05	0.21	0.21	0.25	3.9	3.3	3.3	3.2	0.64	<0.01	0.09
20	Isadore's	182	NNW	28.0	0.088	0.05	1.01	1.01	1.40	4.0	2.6	2.6	2.5	1.33	<0.01	0.14
446	P90$^{(i)}$	182	NNW	0.6	0.002	0.05	0.17	0.17	0.21	3.9	3.3	3.3	3.2	0.56	<0.01	0.09
86	166$^{(d)}$, L12$^{(j)}$	183	N	7.1	0.022	0.04	0.13	0.13	0.15	4.0	3.5	3.5	3.5	0.48	<0.01	0.06
4	Kearl	184	N	71.1	0.169	0.04	0.63	0.63	0.64	3.9	2.7	2.7	2.7	1.17	<0.01	<0.01
187	41$^{(d)}$	185	WNW	72.7	0.300	0.08	0.10	0.10	0.11	3.9	3.7	3.7	3.7	0.14	<0.01	0.04
420	P4$^{(i)}$	188	NNW	2.6	0.007	0.04	0.65	0.65	0.61	3.9	2.7	2.7	2.8	1.18	<0.01	<0.01
78	UNL-1$^{(g)}$	191	N	13.1	0.033	0.04	0.56	0.56	1.52	3.9	2.8	2.8	2.4	1.11	<0.01	0.44
304	D226$^{(h)}$	192	WNW	14.5	0.022	0.05	0.09	0.09	0.10	3.6	3.4	3.4	3.3	0.23	<0.01	0.04
415	P3$^{(i)}$	195	N	1.9	0.005	0.04	0.50	0.50	1.28	3.9	2.8	2.8	2.4	1.07	<0.01	0.41
79	UNL-2$^{(g)}$	195	N	7.4	0.021	0.04	0.97	0.97	1.08	4.0	2.6	2.6	2.6	1.35	<0.01	0.05
419	P38$^{(i)}$	195	N	0.3	0.001	0.04	0.20	0.20	0.24	3.8	3.1	3.1	3.1	0.68	<0.01	0.08
321	L11$^{(j)}$	195	N	19.7	0.059	0.04	0.13	0.13	0.16	4.0	3.5	3.5	3.4	0.48	<0.01	0.06
284	Big Snuff	196	N	17.3	0.054	0.04	0.14	0.14	0.16	4.0	3.5	3.5	3.4	0.49	<0.01	0.07
302	D223$^{(h)}$	196	NW	12.0	0.029	0.05	0.09	0.09	0.10	3.8	3.6	3.6	3.6	0.21	<0.01	0.04
411	P2$^{(i)}$	197	N	2.6	0.006	0.04	0.45	0.45	0.85	3.9	2.9	2.9	2.6	1.02	<0.01	0.27
80	P5$^{(i)}$, UNL-3$^{(g)}$	197	N	3.0	0.007	0.04	0.54	0.54	0.64	3.9	2.8	2.8	2.7	1.10	<0.01	0.07
373	22$^{(f)}$	200	NW	505.6	1.719	0.05	0.09	0.09	0.10	4.0	3.7	3.7	3.7	0.20	<0.01	0.04
85	164$^{(d)}$, 17$^{(f)}$, L10$^{(j)}$	201	N	11.4	0.035	0.04	0.15	0.15	0.17	4.0	3.5	3.5	3.4	0.52	<0.01	0.07
534	Proudfoot	202	NE	31.3	0.136	0.04	0.08	0.08	0.09	4.1	3.9	3.9	3.8	0.25	<0.01	0.05
300	D221$^{(h)}$	203	NW	7.0	0.001	0.05	0.09	0.09	0.10	2.6	2.4	2.4	2.3	0.21	<0.01	0.04
19	Calumet	205	NNW	57.5	0.034	0.05	0.35	0.35	0.43	3.2	2.4	2.4	2.3	0.87	<0.01	0.09
12	LK-7$^{(g)}$	205	NNW	2.1	0.001	0.05	0.39	0.39	0.51	3.2	2.3	2.3	2.2	0.91	<0.01	0.12
89	Rabbit	206	NW	14.6	0.035	0.05	0.09	0.09	0.10	3.8	3.6	3.6	3.5	0.24	<0.01	0.05
488	PW3$^{(i)}$	206	NNW	0.7	0.003	0.05	0.10	0.10	0.12	4.1	3.8	3.8	3.7	0.33	<0.01	0.06
5	McClelland	206	N	230.4	0.393	0.04	0.35	0.35	0.44	3.8	2.8	2.8	2.7	0.91	<0.01	0.10
283	163$^{(d)}$	206	N	10.1	0.024	0.03	0.26	0.26	0.45	4.1	3.1	3.1	2.9	0.93	<0.01	0.25
18	Lillian	206	NNW	7.4	0.004	0.05	0.37	0.37	0.58	3.2	2.3	2.3	2.1	0.89	<0.01	0.20

Table 16 Predicted pH of Snowmelt for the 416 Lake Catchments Included in the Assessment (continued)

Lake Identifier(a)	Lake Name/Original Identifier	Distance [km](b)	Direction(b)	Gross Catchment Area [km^2]	Net Annual Inflow [m^3/s]	Gross Potential Acid Inputs [keq/ha/yr]				Snowmelt pH				Change in pH		
						Background	EAC	Project Case	PDC	Background	EAC	Project Case	PDC	EAC (Relative to Background)	Project Case (Relative to EAC)	PDC (Relative to EAC)
406	P11(i)	207	NNW	2.0	0.008	0.05	0.11	0.11	0.13	4.1	3.7	3.7	3.6	0.39	<0.01	0.06
336	L51(j)	207	NW	65.9	0.180	0.05	0.10	0.10	0.11	3.9	3.6	3.6	3.5	0.27	<0.01	0.05
484	PTH8(i)	207	N	0.6	0.002	0.03	0.23	0.23	0.30	4.1	3.2	3.2	3.1	0.88	<0.01	0.13
487	PW2(i)	207	NNW	0.6	0.002	0.05	0.11	0.11	0.12	4.1	3.7	3.7	3.6	0.36	<0.01	0.06
301	D222(h)	207	NW	4.6	0.001	0.05	0.08	0.08	0.09	2.8	2.6	2.6	2.5	0.18	<0.01	0.04
337	L52(j)	209	NW	11.1	0.034	0.05	0.10	0.10	0.11	3.9	3.7	3.6	3.6	0.26	<0.01	0.05
418	P35(i)	209	N	1.3	0.003	0.03	0.22	0.22	0.31	4.0	3.2	3.2	3.0	0.87	<0.01	0.14
407	P14(i)	210	NNW	8.9	0.034	0.05	0.10	0.10	0.12	4.1	3.7	3.7	3.7	0.34	<0.01	0.06
282	162(d)	210	N	10.2	0.009	0.03	0.20	0.20	0.25	3.6	2.8	2.8	2.7	0.82	<0.01	0.11
486	PW1(i)	210	NNW	1.8	0.008	0.05	0.10	0.10	0.11	4.1	3.8	3.8	3.7	0.32	<0.01	0.06
483	PTH7(i)	210	N	0.9	0.003	0.03	0.21	0.21	0.28	4.1	3.3	3.3	3.1	0.85	<0.01	0.13
443	P86(i)	210	NNW	3.8	0.015	0.05	0.10	0.10	0.11	4.1	3.8	3.8	3.7	0.31	<0.01	0.05
148	P13(i), P13(e)	211	NNW	3.8	0.012	0.05	0.10	0.10	0.11	4.0	3.7	3.7	3.6	0.33	<0.01	0.06
339	L54(j)	212	NW	236.9	0.915	0.05	0.10	0.10	0.11	4.0	3.8	3.8	3.7	0.25	<0.01	0.05
338	L53(j)	213	NW	50.6	0.180	0.05	0.10	0.10	0.11	4.0	3.7	3.7	3.7	0.25	<0.01	0.05
409	P17(i)	214	NNW	0.5	0.002	0.05	0.12	0.12	0.14	4.0	3.6	3.6	3.6	0.40	<0.01	0.06
417	P34(i)	214	N	0.9	0.002	0.03	0.19	0.19	0.24	4.0	3.2	3.2	3.1	0.80	<0.01	0.11
6	LK-1(g)	214	NNW	3.8	0.002	0.03	0.23	0.23	0.54	3.4	2.6	2.6	2.2	0.83	<0.01	0.38
408	P16(i)	214	NNW	1.0	0.004	0.05	0.12	0.12	0.13	4.1	3.7	3.7	3.7	0.39	<0.01	0.06
410	P18(i)	215	NNW	0.6	0.002	0.05	0.12	0.12	0.14	4.0	3.6	3.6	3.6	0.40	<0.01	0.06
482	PTH6(i)	215	N	0.9	0.002	0.03	0.19	0.19	0.24	4.1	3.3	3.3	3.2	0.80	<0.01	0.11
281	161(d)	216	N	8.1	0.011	0.03	0.14	0.14	0.17	3.8	3.1	3.1	3.0	0.67	<0.01	0.08
102	33(f), L33(j)	217	NNW	10.2	0.022	0.05	0.11	0.11	0.12	3.8	3.5	3.5	3.4	0.36	<0.01	0.06
526	Preston	218	NNE	252.5	1.204	0.04	0.08	0.08	0.09	4.2	3.9	3.9	3.9	0.27	<0.01	0.05
481	PTH5(i)	218	N	1.0	0.002	0.03	0.18	0.18	0.24	4.1	3.3	3.3	3.2	0.78	<0.01	0.11
475	PT9(i)	218	NNW	0.6	0.003	0.05	0.12	0.12	0.14	4.1	3.7	3.7	3.6	0.42	<0.01	0.06
278	157(d)	218	N	42.3	0.103	0.03	0.19	0.19	0.27	4.1	3.3	3.3	3.1	0.81	<0.01	0.14
280	160(d)	218	N	24.4	0.063	0.03	0.14	0.14	0.17	4.1	3.4	3.4	3.3	0.67	<0.01	0.08
528	Lloyd	219	NNE	4,250.0	22.599	0.04	0.08	0.08	0.09	4.2	4.0	4.0	3.9	0.26	<0.01	0.04
103	Audet	220	N	96.5	0.208	0.03	0.19	0.19	0.28	4.0	3.2	3.2	3.0	0.80	<0.01	0.16
374	Carrot	221	NW	179.8	0.581	0.05	0.08	0.08	0.09	3.9	3.7	3.7	3.7	0.19	<0.01	0.04
104	Johnson	222	N	73.5	0.151	0.02	0.12	0.12	0.14	4.1	3.4	3.4	3.3	0.68	<0.01	0.08
279	158(d)	222	N	14.5	0.029	0.03	0.14	0.14	0.17	4.0	3.3	3.3	3.2	0.66	<0.01	0.09
299	Chipewyan	222	NW	100.0	0.322	0.05	0.08	0.08	0.09	3.9	3.7	3.7	3.7	0.19	<0.01	0.04
10	LK-5(g)	223	NNW	0.8	0.002	0.03	0.12	0.12	0.14	4.1	3.5	3.5	3.4	0.56	<0.01	0.07
341	L56(j)	224	NW	37.9	0.168	0.05	0.09	0.09	0.10	4.1	3.8	3.8	3.8	0.22	<0.01	0.04
444	P87(i)	224	NNW	4.1	0.022	0.03	0.09	0.09	0.11	4.4	3.9	3.9	3.9	0.45	<0.01	0.05
442	P85(i)	224	NNW	2.2	0.011	0.05	0.09	0.09	0.10	4.2	3.9	3.9	3.9	0.30	<0.01	0.05
17	LK-12(g)	224	NNW	2.5	0.008	0.03	0.12	0.12	0.14	4.1	3.6	3.6	3.5	0.56	<0.01	0.08
340	L55(j)	225	NW	26.2	0.093	0.05	0.09	0.09	0.10	4.0	3.8	3.8	3.7	0.22	<0.01	0.04
441	P84(i)	226	NNW	0.9	0.005	0.05	0.09	0.09	0.10	4.2	3.9	3.9	3.9	0.28	<0.01	0.05
11	LK-6(g)	226	NNW	3.8	0.011	0.03	0.11	0.11	0.13	4.1	3.5	3.5	3.5	0.53	<0.01	0.07
474	PT8(i)	226	NNW	0.1	0.000	0.03	0.12	0.12	0.14	4.2	3.6	3.6	3.6	0.54	<0.01	0.08
436	P70(i)	226	NNW	1.7	0.009	0.03	0.09	0.09	0.10	4.4	4.0	4.0	3.9	0.41	<0.01	0.06
7	LK-2(g)	227	NNW	7.3	0.018	0.03	0.10	0.10	0.12	4.0	3.5	3.5	3.5	0.49	<0.01	0.07
430	P52(i)	229	NNW	0.9	0.001	0.03	0.14	0.14	0.17	3.7	3.0	3.0	3.0	0.62	<0.01	0.09
473	PT6(i)	229	NNW	0.2	0.000	0.03	0.14	0.14	0.17	3.7	3.1	3.1	3.0	0.61	<0.01	0.09
91	Namur	230	NNW	224.0	0.325	0.05	0.09	0.09	0.10	3.6	3.4	3.4	3.3	0.22	<0.01	0.04
426	P48(i)	230	NNW	4.6	0.021	0.03	0.11	0.11	0.14	4.3	3.8	3.8	3.7	0.54	<0.01	0.08
525	Forrest	232	NNE	434.0	2.071	0.03	0.07	0.07	0.08	4.4	4.0	4.0	4.0	0.35	<0.01	0.05
323	S. Gardiner	232	NNW	1,201.3	3.324	0.03	0.08	0.08	0.09	4.1	3.7	3.7	3.7	0.37	<0.01	0.05
277	153(d)	232	N	17.4	0.042	0.03	0.14	0.14	0.18	4.1	3.4	3.4	3.3	0.67	<0.01	0.10
346	Canopener	232	NNW	10.9	0.021	0.03	0.08	0.08	0.09	3.9	3.6	3.6	3.5	0.36	<0.01	0.05
345	Buoy	233	NNW	25.2	0.065	0.03	0.07	0.07	0.08	4.0	3.7	3.7	3.6	0.35	<0.01	0.05
524	Patterson	235	NNE	265.0	1.194	0.03	0.07	0.07	0.08	4.3	4.0	4.0	3.9	0.35	<0.01	0.05
428	P50(i)	235	NNW	2.9	0.015	0.03	0.10	0.10	0.12	4.3	3.9	3.9	3.8	0.48	<0.01	0.07
434	P61(i)	235	NNW	0.8	0.004	0.03	0.08	0.08	0.09	4.3	4.0	4.0	3.9	0.36	<0.01	0.05
429	P51(i)	235	NNW	0.4	0.002	0.03	0.11	0.11	0.13	4.2	3.7	3.7	3.7	0.52	<0.01	0.07

Table 16 Predicted pH of Snowmelt for the 416 Lake Catchments Included in the Assessment (continued)

Lake Identifier(a)	Lake Name/Original Identifier	Distance [km](b)	Direction(b)	Gross Catchment Area $[km^2]$	Net Annual Inflow $[m^3/s]$	Gross Potential Acid Inputs [keq/ha/yr]				Snowmelt pH				Change in pH		
						Background	EAC	Project Case	PDC	Background	EAC	Project Case	PDC	EAC (Relative to Background)	Project Case (Relative to EAC)	PDC (Relative to EAC)
324	N. Gardiner	235	NNW	1,026.5	2.748	0.03	0.07	0.07	0.08	4.1	3.7	3.7	3.7	0.32	<0.01	0.05
412	P20(i)	236	NNW	0.8	0.004	0.03	0.09	0.09	0.10	4.3	3.9	3.9	3.8	0.43	<0.01	0.06
431	P54(i)	236	NNW	0.4	0.001	0.03	0.11	0.11	0.13	4.1	3.6	3.6	3.5	0.51	<0.01	0.07
472	PT5(i)	236	NNW	1.5	0.008	0.03	0.10	0.10	0.12	4.3	3.8	3.8	3.8	0.50	<0.01	0.07
435	P69(i)	237	NNW	1.0	0.006	0.03	0.08	0.08	0.09	4.4	4.0	4.0	4.0	0.37	<0.01	0.05
438	P77(i)	237	NNW	1.3	0.006	0.03	0.09	0.09	0.10	4.3	3.9	3.9	3.9	0.42	<0.01	0.06
439	P79(i)	237	NNW	2.3	0.012	0.03	0.09	0.09	0.10	4.4	3.9	3.9	3.9	0.43	<0.01	0.06
471	PT4(i)	237	NNW	1.7	0.009	0.03	0.09	0.09	0.10	4.4	3.9	3.9	3.9	0.42	<0.01	0.06
151	P49(i), P49(e)	237	NNW	0.8	0.004	0.03	0.10	0.10	0.11	4.4	3.9	3.9	3.8	0.47	<0.01	0.06
93	Legend	237	NW	93.1	0.177	0.05	0.08	0.08	0.09	3.7	3.5	3.5	3.5	0.19	<0.01	0.03
470	PT3(i)	240	NNW	0.6	0.003	0.03	0.08	0.08	0.09	4.3	4.0	4.0	3.9	0.39	<0.01	0.06
527	Beet	241	NNE	456.1	2.408	0.03	0.06	0.06	0.07	4.4	4.1	4.1	4.0	0.33	<0.01	0.05
325	L21(j)	242	NNW	103.2	0.120	0.03	0.07	0.07	0.08	3.7	3.4	3.4	3.3	0.33	<0.01	0.05
326	Sand	243	NNW	604.6	1.602	0.03	0.07	0.07	0.08	4.1	3.7	3.7	3.7	0.34	<0.01	0.05
433	P60(i)	243	NNW	3.5	0.018	0.03	0.08	0.08	0.09	4.4	4.0	4.0	3.9	0.39	<0.01	0.06
333	L45(j)	244	N	36.1	0.069	0.03	0.11	0.11	0.14	4.0	3.4	3.4	3.3	0.58	<0.01	0.09
334	L48(j)	244	NNW	102.6	0.278	0.03	0.07	0.07	0.08	4.1	3.7	3.7	3.7	0.35	<0.01	0.05
328	Clear	245	NNW	107.2	0.303	0.03	0.08	0.08	0.09	4.1	3.7	3.7	3.7	0.36	<0.01	0.05
468	PT1(i)	246	NNW	1.3	0.005	0.03	0.07	0.07	0.08	4.2	3.9	3.9	3.8	0.35	<0.01	0.05
476	PTH1(i)	247	N	1.0	0.001	0.03	0.10	0.10	0.13	3.8	3.3	3.3	3.2	0.54	<0.01	0.09
437	P72(i)	248	NNW	1.7	0.009	0.03	0.07	0.07	0.08	4.3	4.0	4.0	3.9	0.34	<0.01	0.05
469	PT2(i)	249	NNW	1.0	0.005	0.03	0.07	0.07	0.08	4.3	4.0	4.0	3.9	0.34	<0.01	0.05
271	145(d)	249	N	18.6	0.026	0.03	0.10	0.10	0.12	3.8	3.3	3.3	3.2	0.52	<0.01	0.09
108	Waterlily	249	NNW	23.2	0.085	0.03	0.07	0.07	0.08	4.2	3.9	3.9	3.8	0.34	<0.01	0.04
92	Otasan	249	NNW	23.4	0.043	0.03	0.07	0.07	0.08	3.9	3.6	3.6	3.5	0.33	<0.01	0.05
344	L59(j)	249	NNW	201.4	0.521	0.04	0.07	0.07	0.08	4.0	3.7	3.7	3.7	0.25	<0.01	0.04
343	L58(j)	250	NW	14.4	0.029	0.05	0.07	0.07	0.07	3.7	3.6	3.6	3.6	0.11	<0.01	0.04
275	151(d)	250	N	92.0	0.268	0.02	0.08	0.08	0.09	4.2	3.7	3.7	3.6	0.51	<0.01	0.08
107	L60(j), L60(e)	251	NNW	60.2	0.163	0.04	0.07	0.07	0.08	4.0	3.7	3.7	3.7	0.26	<0.01	0.04
480	PTH2(i)	251	N	1.2	0.002	0.03	0.09	0.09	0.12	3.9	3.4	3.4	3.3	0.50	<0.01	0.09
342	L57(j)	251	NW	198.4	0.512	0.05	0.07	0.07	0.08	3.8	3.7	3.7	3.7	0.12	<0.01	0.03
327	Eaglenest	251	NNW	128.4	0.307	0.03	0.07	0.07	0.08	4.0	3.7	3.7	3.6	0.34	<0.01	0.05
270	143(d)	251	N	28.3	0.045	0.03	0.10	0.10	0.12	3.9	3.4	3.4	3.3	0.50	<0.01	0.08
99	144(d), L43(j)	251	N	23.0	0.047	0.03	0.10	0.10	0.12	4.0	3.5	3.5	3.4	0.50	<0.01	0.08
332	L44(j)	251	N	9.4	0.002	0.03	0.10	0.10	0.12	3.0	2.5	2.5	2.4	0.50	<0.01	0.08
274	149(d)	251	N	7.1	0.013	0.03	0.09	0.09	0.11	3.9	3.5	3.5	3.4	0.49	<0.01	0.08
276	152(d)	252	N	21.9	0.028	0.03	0.09	0.09	0.11	3.8	3.3	3.3	3.2	0.49	<0.01	0.08
273	148(d)	253	N	6.2	0.010	0.03	0.09	0.09	0.11	3.9	3.4	3.4	3.3	0.48	<0.01	0.08
98	146(d), L40(j)	253	N	5.6	0.002	0.03	0.09	0.09	0.11	3.1	2.6	2.6	2.5	0.48	<0.01	0.08
330	L41(j)	254	N	36.5	0.046	0.03	0.09	0.09	0.11	3.8	3.3	3.3	3.2	0.48	<0.01	0.08
105	150(d), 9(f), L39(j), A-150(L39)(e)	256	N	19.2	0.050	0.02	0.08	0.08	0.09	4.2	3.7	3.7	3.6	0.52	<0.01	0.08
106	Bayard	256	NNW	57.2	0.169	0.03	0.07	0.07	0.08	4.1	3.8	3.8	3.7	0.32	<0.01	0.05
269	142(d)	256	N	36.6	0.087	0.03	0.09	0.09	0.11	4.1	3.6	3.6	3.5	0.46	<0.01	0.08
268	141(d)	256	N	42.8	0.078	0.03	0.09	0.09	0.11	3.9	3.5	3.5	3.4	0.47	<0.01	0.08
262	Dianne	256	NNW	295.8	0.515	0.03	0.09	0.09	0.10	3.9	3.5	3.5	3.4	0.42	<0.01	0.07
100	27(f), L47(j), L47(e)	257	NNW	49.2	0.102	0.04	0.07	0.07	0.08	3.9	3.6	3.6	3.6	0.25	<0.01	0.04
335	L50(j)	258	NNW	14.4	0.028	0.04	0.07	0.07	0.08	3.8	3.6	3.6	3.6	0.24	<0.01	0.04
267	139(d)	258	N	10.5	0.011	0.03	0.09	0.09	0.10	3.7	3.2	3.2	3.1	0.46	<0.01	0.08
265	Pearson	258	N	16.8	0.014	0.03	0.09	0.09	0.11	3.6	3.1	3.1	3.0	0.48	<0.01	0.08
331	L42(j)	259	N	49.6	0.074	0.03	0.09	0.09	0.10	3.9	3.4	3.4	3.3	0.45	<0.01	0.08
272	Poplar	259	N	48.0	0.117	0.03	0.08	0.08	0.10	4.1	3.6	3.6	3.5	0.45	<0.01	0.08
266	Kress	259	N	31.0	0.066	0.03	0.09	0.09	0.10	4.0	3.5	3.5	3.5	0.46	<0.01	0.08
101	L49(j), L49(e)	260	NNW	31.1	0.067	0.04	0.07	0.07	0.08	3.9	3.6	3.6	3.6	0.26	<0.01	0.04
264	136(d)	260	N	5.2	0.003	0.03	0.09	0.09	0.11	3.4	3.0	3.0	2.9	0.47	<0.01	0.08
263	134(d)	262	N	8.2	0.007	0.03	0.08	0.08	0.10	3.5	3.2	3.2	3.1	0.40	<0.01	0.07
260	131(d)	262	NNW	11.9	0.013	0.03	0.08	0.08	0.09	3.7	3.3	3.3	3.2	0.36	<0.01	0.06
261	Ronald	263	NNW	346.1	0.564	0.03	0.08	0.08	0.09	3.8	3.5	3.5	3.4	0.37	<0.01	0.07
351	L68(j)	264	NNW	2.1	0.004	0.03	0.07	0.07	0.07	3.9	3.6	3.6	3.6	0.31	<0.01	0.04

Table 16 Predicted pH of Snowmelt for the 416 Lake Catchments Included in the Assessment (continued)

Lake Identifier[a]	Lake Name/Original Identifier	Distance [km][b]	Direction[b]	Gross Catchment Area $[km^2]$	Net Annual Inflow $[m^3/s]$	Gross Potential Acid Inputs [keq/ha/yr]				Snowmelt pH				Change in pH		
						Background	EAC	Project Case	PDC	Background	EAC	Project Case	PDC	EAC (Relative to Background)	Project Case (Relative to EAC)	PDC (Relative to EAC)
352	L69[j]	264	NNW	2.4	0.004	0.03	0.06	0.06	0.07	3.9	3.6	3.6	3.5	0.29	<0.01	0.04
348	Currie	267	N	15.5	0.023	0.03	0.08	0.08	0.09	3.8	3.4	3.4	3.4	0.41	<0.01	0.07
95	29[f], L27[j]	267	NW	12.6	0.023	0.04	0.06	0.06	0.07	3.8	3.6	3.6	3.6	0.20	<0.01	0.03
350	Harwood	268	N	9.1	0.014	0.02	0.07	0.07	0.09	4.0	3.5	3.5	3.4	0.49	<0.01	0.08
349	Archer	273	N	42.9	0.087	0.02	0.07	0.07	0.08	4.1	3.6	3.6	3.5	0.47	<0.01	0.07
347	L64[j]	275	N	9.7	0.002	0.03	0.07	0.07	0.09	2.9	2.6	2.6	2.5	0.39	<0.01	0.07
96	28[f], L28[j], L28[e]	280	NNW	19.0	0.045	0.04	0.07	0.07	0.07	3.9	3.7	3.7	3.7	0.23	<0.01	0.04
97	Clayton	283	NNW	13.1	0.033	0.03	0.06	0.06	0.06	4.0	3.8	3.8	3.8	0.24	<0.01	0.04
529	Sandy [h]	304	N	452.7	0.624	0.02	0.05	0.05	0.06	3.9	3.6	3.6	3.5	0.35	<0.01	0.06
531	Cluff	309	NNE	219.0	1.256	0.03	0.05	0.05	0.06	4.4	4.2	4.2	4.1	0.24	<0.01	0.05

[a] Identifier used on map showing lake locations.

[b] Distance and direction relative to the MEG CLRP.

[c] Identifier used in the Water Quality Baseline Report for this study (Volume 4, Appendix 4-IV).

[d] Identifier used by previous EIAs, refer to Section 5.3.

[e] Identifier used by RAMP (2004).

[f] Identifier used by Erickson (1987).

[g] Identifier used by Saffran and Trew (1996).

[h] Identifier used by Syncrude (2000).

[i] Identifier used by WRS (2004) for one hundred ponds sampled within Oil Sands Region during September 2000.

[j] Identifier used by WRS (2004) for a survey of 34 lakes conducted by Alberta-Pacific Forest Industries in 1999.

– = No data.

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